ARMY
NAVY
AIR FORCE

TM 5-631
NAVFACM0-100.2
AFM 126-3

TECHNICAL MANUAL

NATURAL RESOURCES
FOREST MANAGEMENT

DEPARTMENTS OF THE ARMY, THE NAVY, AND THE AIR FORCE
DECEMBER 1981

FOREWORD

This manual, together with the following manuals, provides guidance, standards, and technical information to personnel concerned with the protection and management of Natural Resources at Department of Defense installations:

Land Management—TM 5-630, AFM 126-2, and NAVFAC MO-100.1

Fish and Wildlife Management—TM 5-633, AFM 126-4, and NAVFAC MO-100.3

Outdoor Recreation and Cultural Values—TM 5-635, AFM 126-5, and NAVFAC MO-100.4

Advice concerning any procedure within this manual may be obtained from:

a. Department of the Army—Office of the Chief of Engineers (DAEN-MPO-B)

b. Department of the Air Force—Directorate of Engineering and Services AF&LEEV.

c. Department of the Navy—Naval Facilities Engineering Command (2042) or its Geographic Engineering Field Division (243).

Recommendations or suggestions for modification, or additional information and instructions that will improve the publication and motivate its use, are invited and should be submitted through appropriate channels to the addresses listed above.

*TM 5-631
AFM 126-3
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DEPARTMENT OF THE ARMY, THE
AIR FORCE, AND THE NAVY
WASHINGTON, DC, *15 December 1981*

NATURAL RESOURCES
FOREST MANAGEMENT

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*This manual supersedes TM 5-631 and NAVDOCKS P-52, 2 April 1963.

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CHAPTER 1

GENERAL

1-1. **Purpose.** Provide guidance, standards, and technical aids to foresters, land managers, and others concerned with the protection and management of forest land at Department of Defense installations. Because of the wide variety of types and sites found in the regions of the United States, the practices set forth are general in nature.

1-2. **Scope.** The material contained in this manual has been developed by the Departments of the Army, Air Force, Navy and Marines. The text includes timber inventory guidelines, timber sales and harvest procedure, and silvicultural practices which provide a sustained environment for the long range support of military mission requirements.

1-3. **Environmental Considerations.** Applicable portions of environmental statutes, implementing regulations and Executive Orders as set forth in AR 200-1; AFR 19-2; MCO P11000.8 and OPNAV INST 6240.3E (APP D) will be complied with.

1-4. **Proponent and User COMMENTS.** The proponent agency of this manual is the Office of the Chief of Engineers, Department of the Army. Users are invited to send comments and suggested improvements on DA Form 2028 (Recommended Changes to Publications and Blank Forms) to HQDA (DAEN-MPO-B) Wash, DC. 20314.

CHAPTER 2

MANAGEMENT

2-1. Objectives.

2-1.1. Contribute forest products to the local and national economy.

2-1.2. Provide for the optimum sustained production of forest products consistent with the military mission and multiple natural resources uses, with special attention to cultural resources. (Included are protection of threatened and endangered species; and preservation of archeological and historical sites.)

2-1.3. Enhance military training facilities by providing accessible forestland cover (through proper silvicultural practices), buffer zones, recreation areas and scenic values.

2-1.4. Develop and maintain wildlife habitat within the concept of normal forest management principles.

2-2. Special Considerations.

2-2.1. Forest tree species to be featured will normally be determined by land use capabilities and military requirements. The selection may be altered to provide optimum barriers, camouflage, screening, aesthetics, wildlife habitat, and special training.

2-2.2. Construction project plans and specifications will include provisions for timely removal of all merchantable timber. Under emergency, or short notice situations merchantable timber will be stockpiled for disposal by timber sale.

2-2.3 Maintain seed trees on impact areas whenever practical.

2-2.4. The hazards of fire and explosion, and metal in the timber on military installations are far greater than in commercial forestlands. Management and disposal operations must consider these hazards.

2-2.5. Guidance for disposal of contaminated timber is as follows:

2-2.5.1. Standing timber which has been contaminated with military metal (bullets, shrapnel, etc.) should be removed by harvesting if at all possible.

2-2.5.2. Heavily contaminated trees may be used for military training exercises where whole material is required. Less contaminated trees may be disposed of by sale for poles, piling and posts. Areas with light or scattered contamination will be made available for lumber products and pulpwood. Knowledge of, or probability of, metal contamination should be made known at the time the declaration of availability is submitted. Lead bullets do not normally affect merchantability but may reduce the stumpage price. Some wood-using industries have installed metal detectors at the mill, but portable detectors may be used successfully by harvest contractors. Metal detectors may be provided for use on sales known to contain metal contamination.

2-2.5.3. Following unsuccessful attempts to dispose of contaminated timber through normal harvesting, consideration should be given to deadening contaminated timber (when not required for seed trees) prior to regeneration. Such action should be limited to managed forest land not planned for military firing range use in the foreseeable future.

2-2.6. Safety considerations will be included in all aspects of forest management to insure the safety of personnel participating in the forest management program. Safety guidelines are contained in appendix D, No. 3.

2-3. Personnel. The personnel requirements vary with the forest acreage, complexity of management, volume and value of timber, and difficulties involved in maintaining protection from fire, insect, and disease. (Appendix E is a guide for determining requirements for personnel and equipment.)

2-3.1. Personnel are encouraged to attend professional meetings, seminars, or short courses offered by universities, U.S. Forest Service and other organizations to keep abreast with current developments and techniques of forest management.

2-3.2. The workshop method is an excellent procedure for training foresters. The workshop is not a substitute for on-the-job training, but serves as a means of improving overall techniques of protection and management, introducing new equipment, and demonstrating better methods of equipment use. The workshop should be conducted at an installation having an active forest management program and suitable quarters for visitors.

2-3.3. On-the-job training by doing, supported by

lectures, charts, and demonstrations, is essential at the installation level. When feasible, invite specialists from state and Federal agencies to assist with lectures and demonstrations.

2-4. Planning.

2-4.1. General. The first step in management is to develop the written plan. Air Force installations will use the Forest Management Plan format prescribed by AFR 126-1. The outline for the Forest Management Plan is presented in appendix A.

2-4.1.1. Start with preparation of the fire protection portion of the overall plan (app D, No. 3). When the Fire Protection Plan is completed and approved, develop remaining parts of the full plan.

2-4.1.2. Keep the approved management plan alive by revision and amendments.

2-4.1.3. A pressboard binder which will hold the entire plan including the maps and charts offers a satisfactory means of presenting, protecting, and filing the completed plan.

2-4.2. Steps in preparing the plan.

2-4.2.1. Base map. Select a suitable base map. Aerial mosaics make very useful base maps. Military quadrangle sheets and/or geological survey maps may be necessary to coordinate all activities. These provide military training coordinates, public land survey designations for coordinating fire data with state towers, and necessary contours and elevations.

2-4.2.2. Aerial photographs. For assistance in obtaining photographs see Timber Inventory (app. B).

2-4.2.3. Land use map. Prepare a basic land use map of the reservation. On it outline improved grounds, semi-improved grounds, firing ranges, impact areas, antenna fields, ammunition storage areas, and other land areas not in the forest category. The remaining area is the forestland to be placed under management. Determine the overall forest acreage by planimeter, modified acreage grid, or other suitable method.

2-4.2.4. Forest stand map. A stand map is justified when—

2-4.2.4.1. There are two or more easily recognized major forest type groups. Example: Upland pine and bottomland hardwood.

2-4.2.4.2. Broad age classes of even-aged stands exist over extensive areas. For most localities, the following stand-size classes are sufficient: sawtimber stands, pole timber stands, seedling and sapling stands, and nonstocked areas. Age classes may be used to supplement the stand-size classification. The merchantability and volume in each stand-size class depends on timber type and site class.

2-4.2.4.3. There are pronounced differences in conditions that have resulted from burning, cutting, thinning, or other practices:

2-4.2.4.3.1. The minimum stand to be recognized generally, is 10 acres of productive forest. (This acreage may be reduced as necessary to include special areas, e.g., black walnut). Prepare stand maps from aerial photos by photo interpretation techniques if trained personnel and special equipment are available. Request assistance from the nearest forest experiment station or regional office of the Forest Service, U.S. Department of Agriculture, or use ground reconnaissance and map sketching with the help of aerial photos.

2-4.2.4.3.2. In determining condition classes to be recognized, it is better to have a few condition classes which are useful in locating and managing timber than to have too many.

2-4.2.5. The cutting cycle. Establish the cutting cycle. This is the planned period within which all compartments (app B) producing merchantable timber are cut over once, in orderly sequence.

2-4.2.5.1. Different cutting cycles for different species are not necessary; adjust essential differences in treatment of various species by changing the marking rules (para 2-5 below).

2-5.2.5.2. Establish the cutting cycle as 10 years for the initial stages of management, when not determined by other methods.

2-4.2.6. Compartment determination. Select compartments and define on a map (app B). Compartments are subdivisions of the forestland established for purposes of orientation, administration, protection, and silvicultural operations, and defined by permanent or semipermanent boundaries. The boundaries may be natural features or manmade lines, which do not necessarily coincide with stand boundaries.

2-4.2.6.1. Number of compartments. The number of compartments established will be 5 to 10, depending on the growth rate. They should be approximately equal in area, if this is feasible. Use roads, streams, reservation boundaries, and other clearly defined physical lines as the compartment boundaries. Use legal subdivisions if convenient. Military subdivisions are useful in some instances.

2-4.2.6.2. Order of cutting. After the compartments have been established, determine the order of cutting on the basis of worst first silvicultural need. Designate the compartment most in need of cutting as "Compartment I," the next as "Compartment II," and so on. If new construction

or other developments eliminate from the forestland all or a large portion of a compartment, that compartment may be dropped. The forest acreage remaining is added to the area of an adjacent compartment.

2-4.2.7. Cutting units. Cutting units are subdivisions of the compartment usually about 40 acres in area. In the case of stand management, individual stands will substitute for cutting units, regardless of their size. Cutting units, or stands, increase efficiency in timber marking and estimating, provide identifiable units for work assignments, are useful in describing fire locations, and in recordkeeping. Delineate cutting units or stands on the compartment map and on the ground, and identify by numbers.

2-4.2.8. Timber inventory. An approximation of the volume is essential to long-range planning. It is important to know what is available in terms of products to be produced, where the volumes are located, priorities of harvest or cultural treatments, and the prospective productivity. Appendix B provides guidelines for preparing a Timber Inventory.

2-4.3. Plans for Small Forestlands. The following modifications of the management practices outlined for larger installations may be made for small forests:

2-4.3.1. The forest area should be divided into compartments and a 5- to 10-year cutting cycle used where practical. If the forest occurs in several scattered blocks, they may be identified as compartments, for reference purposes.

2-4.3.2. Annual harvests can be planned if the area is large enough or it may be satisfactory and more profitable to prescribe periodic instead of annual harvests. Harvest should be planned with sufficient volume per acre to attract competitive bids.

2-4.3.3. Neither the absence of an installation forester nor the use of periodic harvests need lessen the quality of marking and other forest care. Obtain professional services from higher levels, or request assistance from State or Federal foresters, or use professional consultant forester services contracts. Teach marking rules to non-professional personnel, and prepare a work program covering a period of several years.

2-4.3.4. On smaller installations, wildfire occurrence is at a lower frequency than on larger installations and protection practices should be modified.

2-4.4. Annual Work Plan. In advance of each fiscal year prepare a work plan which describes the types and magnitude of work to be performed during the ensuing year. A copy of the annual work plan should be made a part of the forest management plan (app A).

2-4.5. Revising the Forest Management Plan:

2-4.5.1. Annual revisions. The purpose of annual revisions is to furnish revised data to support actions proposed in the plan, and to correct information furnished originally. Page revisions normally are adequate for corrections; changes in personnel requirements; and record of fires, and estimated damage (acres and value) resulting thereform. Page revisions should be inserted in the installation forest management plan, and a copy forwarded to appropriate headquarters.

2-4.5.2. Complete revisions. An active forest management program on an installation normally requires periodic complete revision of the plan. Five-year intervals are usually desirable. However, 10-year intervals are frequently used within the Air Force, Navy, and Marine Corps. These revisions should summarize the data furnished in the original plan and subsequent annual revisions. Other items may include: revised compartmentation and cutting units, and changes in marking rules and cutting budgets. Complete revision may require fieldwork, especially when new rates of growth and volume determinations and stand mapping are needed.

2-5. Timber Sales Procedure.

2-5.1. General. Remove from the stand those trees which would otherwise be wasted by death and decay, or will interfere with the growth rate or survival of more desirable trees. There are three primary methods for eliminating such trees:

2-5.1.1. Commercial sale. This is the principal method of preventing waste and improving the stand.

2-5.1.2. Timber stand improvement, by cutting or deadening undesirable trees and species. No utilization is attempted, unless there is a local demand for firewood.

2-5.1.3. Installation utilization, by cutting and removing marked trees in the course of training or by use of grounds maintenance crews.

2-5.2. Timber Cutting Designation. Trees to be removed will be selected in advance and designated by marking, specifying diameter limits, or area boundary designation. Develop marking rules in writing for each type of intermediate and harvest cutting. The following guidelines apply:

2-5.2.1. Mark for removal the following classes of trees (Fig. 2-1).

2-5.2.1.1. Sanitation Trees. Those trees in which the presence of wood destroying fungi are unmistakably evident. Sanitation trees will be retained

only when better trees are not available and seed trees are essential.

2-5.2.1.2. Poor risk trees. Included are those in which the loss of marketable wood currently exceeds the annual growth of new wood; those which are overmature and suppressed, unthrifty due to insect or fungus attack, or weakened mechanically and subject to windthrow; and those damaged by fire, turpentining, lightening, logging, or insects. Poor risk trees may be left as seed trees when no better trees are available.

2-5.2.1.3. Mature trees. Trees which have just passed the peak of annual growth and natural vigor as indicated by crown appearance and by increment borings. Removal of these trees will be dictated by the method of regeneration designated in the forest management plan.

2-5.2.1.4. Thinnings. Those trees of marketable size that are least desirable and should be removed to give proper growing space to better trees.

2-5.2.1.5. Culls and undesirable species. Those trees of merchantable size which are considered to be unmerchantable or are of undesirable species. As an exception, individuals of undesirable species if thrifty, of high quality, and not in competition with better trees may be retained for possible future demand.

2-5.2.1.6. Metal contaminated timber (See para 2-2).

2-5.2.2. Environmental considerations in timber marking. During timber marking and harvesting operations, consideration must be given to: enhancing wildlife habitat, aesthetic values, outdoor recreation benefits, watersheds, protection of endangered and threatened species of fauna and flora and their critical habitats, and to protecting special interest areas.

2-5.2.2.1. Wildlife habitat. Normally, wildlife habitat enhancement should be considered during all marking operations. Active den trees should be left for squirrel, raccoon, wood ducks, red-cockaded woodpeckers, and owls. Bird rookeries should be left uncut. Consideration will be given to leaving desirable food trees such as oak, hickory, beech, black gum, black walnut, pecan, cherry, persimmon, dogwood, crabapple, and hawthorne, preferably in groups. The maintenance of groups of hardwoods in Southern pine forests is more beneficial to wildlife than leaving a few scattered individual hardwoods. Small openings from three to five acres in size should be established in dense canopy forests for turkey, grouse, deer, and cottontail. Dead trees and snags should be left standing to provide food and shelter for many small wildlife species including song birds, unless they create hazardous conditions for forest destroying insects, disease, and lighting strike fires. During intermediate markings for pine thinning maintain a semi-open canopy by cutting back sufficiently to stimulate a faster growth rate on the residual trees thus allowing sunlight to reach the forest floor. This in turn stimulates growth of grasses, forbs, and woody vegetation, providing desirable food and cover for deer, turkey, grouse, quail, cottontail, and song birds. Refer to the installation fish and wildlife management plan for specific wildlife requirements.

2-5.2.2.2. Aesthetic values. Aesthetic values must be taken into consideration when marking trees along heavily traveled roads and highways, in cantonment areas, and adjacent to lakes and streams. Normally, only light cuttings are made along the edge or sight zone of these scenic areas.

2-5.2.2.3. Outdoor recreation benefits. Special marking will be made in outdoor recreation areas to enhance these values. Marking may be limited to those trees which are susceptible to wind breakage or to open up dense stands for optimum crown development. Outdoor recreation areas include picnic areas, camping sites, hiking and jogging trails, bird watching and nature trails, and ski slopes. Refer to the installation outdoor recreation plan for specific requirements.

2-5.2.2.4. Watersheds. Normally, only light thinnings or harvest cuttings are made on watersheds to prevent erosion, heavy runoff, siltation and contamination. Care must be taken when marking trees in reservoir watershed areas. Buffer zones shall be established and maintained along all principal streams and water bodies.

2-5.2.2.5. Endangered and threatened species. When marking trees in areas which contain endangered or threatened species of fauna or flora, special care must be exercised to protect and/or enhance these species. When habitat for an endangered species is located on the installation, complete protection of the site may be required. (Ref Section 7 of the Endangered Species Act of 1973). When endangered or threatened species are involved, formal consultation must be made with appropriate state and U. S. Department of the Interior personnel to determine if any timber cutting is allowed in and adjacent to those areas.

2-5.2.2.6. Special interest areas. The presence of special interest areas (archaeological, botantical, ecological, geological, and historical) will also determine the intensity of marking and cutting. Some sites such as natural areas will require no timber cutting. Refer to the installation outdoor recreation plan concerning the location and specific requirements for these special interest areas.

2-5.3. Timber Harvesting. Commercial Sales:

2-5.3.1. Written release. For land leased from

private owners, the real estate officer must secure written approval of the lessor unless specifically permitted by the lease.

2-5.3.2. Map. Prepare a reproducible map to delineate the cutting area. Show all economically operable areas, danger areas, off-limit areas, live firing range boundaries, main roads, wood roads, firebreaks, streams, available mill sites (if any), compartment and cutting unit identification, and any other features important is logging, hauling, and milling operations.

2-5.3.3. Marking. Trees marked for removal shall be designated with tree marking paint (fig. 2-2).

2-5.3.3.1. In selective cutting every tree to be removed is marked at breast height (4 1/2 to 5 feet above ground) and on the stump at ground line. Use only one color of paint (yellow as a rule), and face all marks in the same direction (Fig. 2-3).

2-5.3.3.2. When an area is to be clear cut to remove all merchantable timber, mark only the boundary trees. Place the marks 5 feet high facing into the tract to be cut. Do not cut boundary trees.

2-5.3.4. Volume estimates.

2-5.3.4.1 Obtain the volume estimate as the trees are marked. If the stand is to be clear cut, marking is unnecessary, but the volume of merchantable timber must be determined and documented.

2-5.3.4.2. Compute volumes separately for major species and product utilization.

2-5.3.4.3. For species of lesser value, combine volumes into "mixed conifers" or "mixed hardwoods."

2-5.3.4.4. The estimate should be sufficiently accurate to provide appraisal data.

2-5.3.5. Statements of availability. When required prepare a declaration of availability (APP C) for submission to the designated approval authority.

2-5.3.6. Merchantability. Clearly define the merchantability standards used for volume determination of various species and products. The following are examples.

2-5.3.6.1. Logs. A merchantable pine sawlog is defined as being not less than 8 feet long and 6 inches inside bark at the small end. A hardwood log is at least 8 feet long and no less than 10 inches in diameter inside bark at the small end.

NOTE: Logs are generally considered unmerchantable if net scale is less than one-third of gross scale.

2-5.3.6.2. Trees. A merchantable sawtimber tree is defined as containing at least one merchantable sawlog. A merchantable pulpwood tree must produce in the stem no less than two pulpwood bolts 5 feet long and no less than 4 inches inside bark at the small end.

Note: Local practices may require consideration of other specifications.

2-5.3.7. Other conditions. Other conditions to be included in the scale specifications are:

2-5.3.7.1. How slash and tops are to be disposed of, if necessary, and expected standards of performance.

2-5.3.7.2. Time period or date by which cutting must be completed. This is especially important for "crash" programs necessary to clear land, stop insect attacks, or salvage storm damaged timber. Ordinarily the contract period should provide ample time to permit completion as determined by local practices without conflict with anticipated military training.

2-5.3.7.3. Explain if loggers will be permitted to operate only on specified days of the week.

2-5.3.7.4. Provision for penalty payments for logging damage to other standing trees, drainage systems, roads, firebreaks, and the like.

2-6. Management Records. Adopt a system to provide a useful, easy-to-understand, and economical-to-maintain record of the annual accomplishments.

2-6.1. A written record will be maintained.

2-6.1.1. For each management unit:

2-6.1.1.1. Installation identification and locations.

2-6.1.1.2. The fiscal years covered by the record.

2-6.1.1.3. The name or number of compartment and cutting unit to which the record pertains.

2-6.1.1.4. The gross and managed forest acreage in the unit.

2-6.1.1.5. Products removed, by type and volume.

2-6.1.1.6. Contract numbers, if removed by scale or harvest.

2-6.1.1.7. Timber sale receipt information.

2-6.1.1.8. Reforestation record in acres, number of trees planted, percent surviving, acres remaining to be planted.

2-6.1.1.9. Record timber stand improvement, control of insects and disease and other management activities.

2-6.1.2. Record costs by fiscal years including sale administrative costs.

2-6.2. Management Map. (The fire record is maintained on a separate map, as described in APP D, No. 3) The management map should be color coded to show:

2-6.2.1. The compartments and planned year for cutting.

2-6.2.2. The areas marked.

2-6.2.3. The areas reported available for disposal.

2-6.2.4. The areas assigned for installation cutting, including troop training and other post needs.

2-6.2.5. Progress of cutting.

2-6.2.6. Reforestation planned.

2-6.2.7. Reforestation completed.

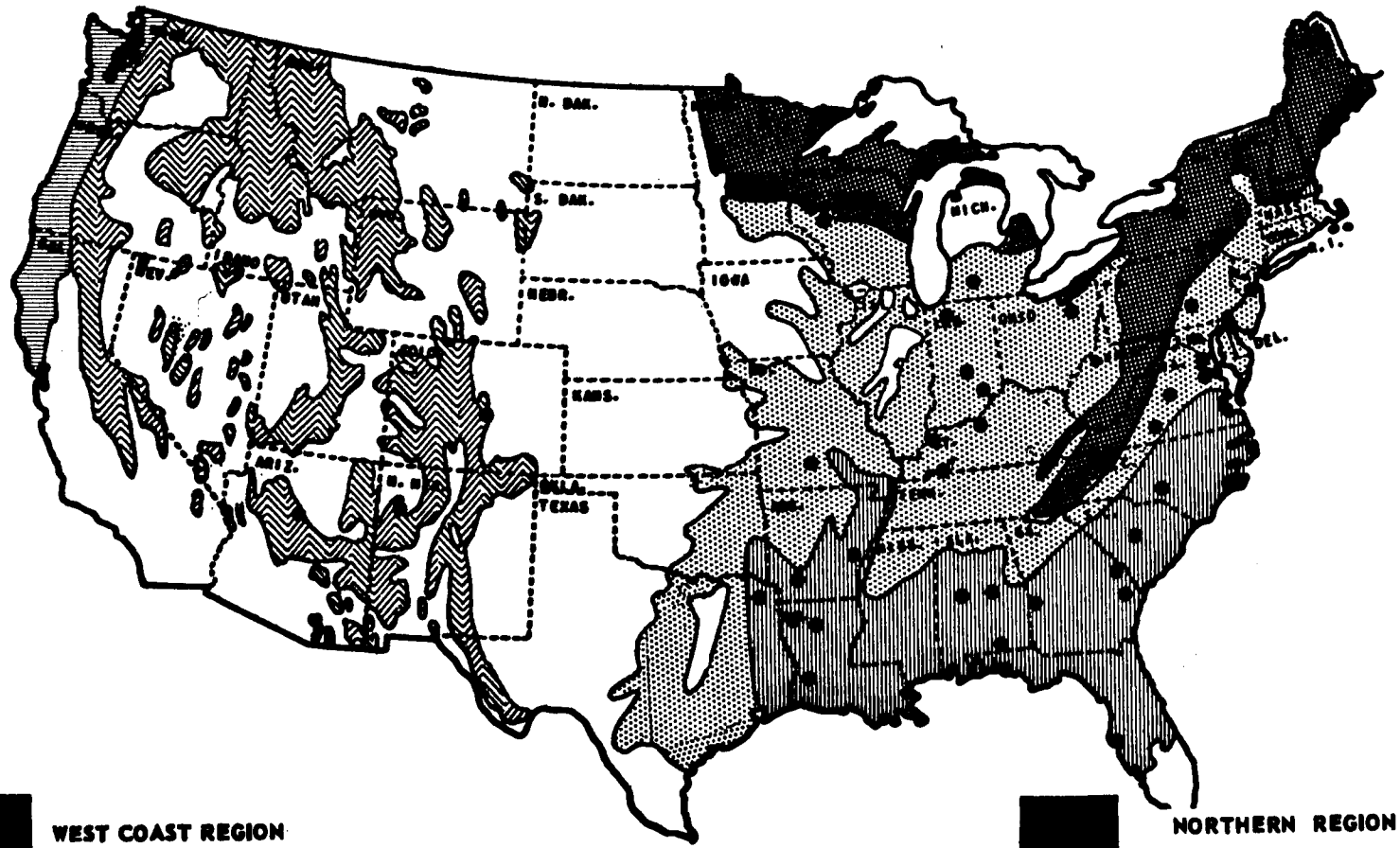
2-6.2.8. Timber stand improvement planned.

2-6.2.9. Timber stand improvement completed.

2-6.2.10. Volume records.

Note: Air Force, Navy, and Marine personnel refer to AFR 126-1/NAVFAC INST 11015.9A/MCO P-11000.8.

2-6.3. Tabular Aids. Miscellaneous data such as measurement equivalents, weights of commercially important woods and conversion factors are presented in appendices F to J inclusive.



WEST COAST REGION

Douglas fir; western hemlock; redwood; western red cedar; Sitka spruce; sugar pine; lodgepole pine; incense cedar; white fir; Port Orford cedar; and others.

WESTERN REGION

Ponderosa pine; Idaho white pine; western larch; Engelmann spruce; Douglas fir; lodgepole pine; sugar pine; western red cedar; western hemlock; white fir; and others.

CENTRAL REGION

Northern portion - oaks; hickories; ashes; elms; maples; beech; black walnut; pitch; shortleaf and Virginia pines, cottonwood; and others.

NORTHERN REGION

Red, black and white spruces; balsam fir; white, red, jack and pitch pines; eastern hemlock; maples, oaks, beech birches, aspen.

SOUTHERN REGION

Longleaf, shortleaf, loblolly and slash pines; southern oaks; red gum; hickories; southern cypress; eastern and southern red cedars; and others.

Figure 2-1. Types of cuttings.

Figure 2-2. Paint marking tree

Figure 2-3. Young Southern Yellow Pine stand before thinning.

CHAPTER 3

PROTECTION

3–1. General. Adequate protection against fire, insects, disease, and other enemies is the first major accomplishment to be sought in developing forest management. Nationwide, insects and diseases are the most destructive enemies of timber. Fire is, however, the most common and most spectacular enemy, and the most destructive of human life, property and wildlife. (For fire protection see app D, No. 3).

3–2. Insect, Disease, and Other Enemies.

3-2.1. Pests of Vegetation. These are discussed in appendix D, No. 3.

3-2.2. Livestock.

3-2.2.1. Where hardwoods are the predominant crop, exclude livestock completely. Livestock prevent regeneration of desirable timber species, damage good trees by browsing, and their trampling may inhibit reproduction.

3-2.2.2. In the longleaf-pine type, exclude hogs. Range hogs eat the pine seedlings and prevent reproduction.

3-2.2.3. In other conifer types, light grazing by cattle (only) may be justified. Maximum stocking in any case should not exceed 1 head to 40 acres.

3-2.3. Trespass. On military installations unauthorized cutting of timber is minor in occurrence and extent. Some thefts occur where the timber is good and the property line is not well marked.

3-2.3.1. The best preventive is to clearly identify the property lines. Patrols at irregular intervals further discourage theft. Investigate signs of recent log skidding and equipment tracks entering the installation. Require all equipment moving forest products across or out of the installation to carry a permit, or other evidence of authorization to be on the installation, together with proof of legal title to the products being hauled.

3-2.3.2. When legal action becomes necessary in case of timber trespass, prepare evidence which will stand up in court. Include estimates of the volume removed, the stumpage and sale values of the stolen timber, and the dollar and volume losses of growth projected to planned year of harvest. Such evidence must be determined by a professional forester.

CHAPTER 4

SILVICULTURE

4–1. General

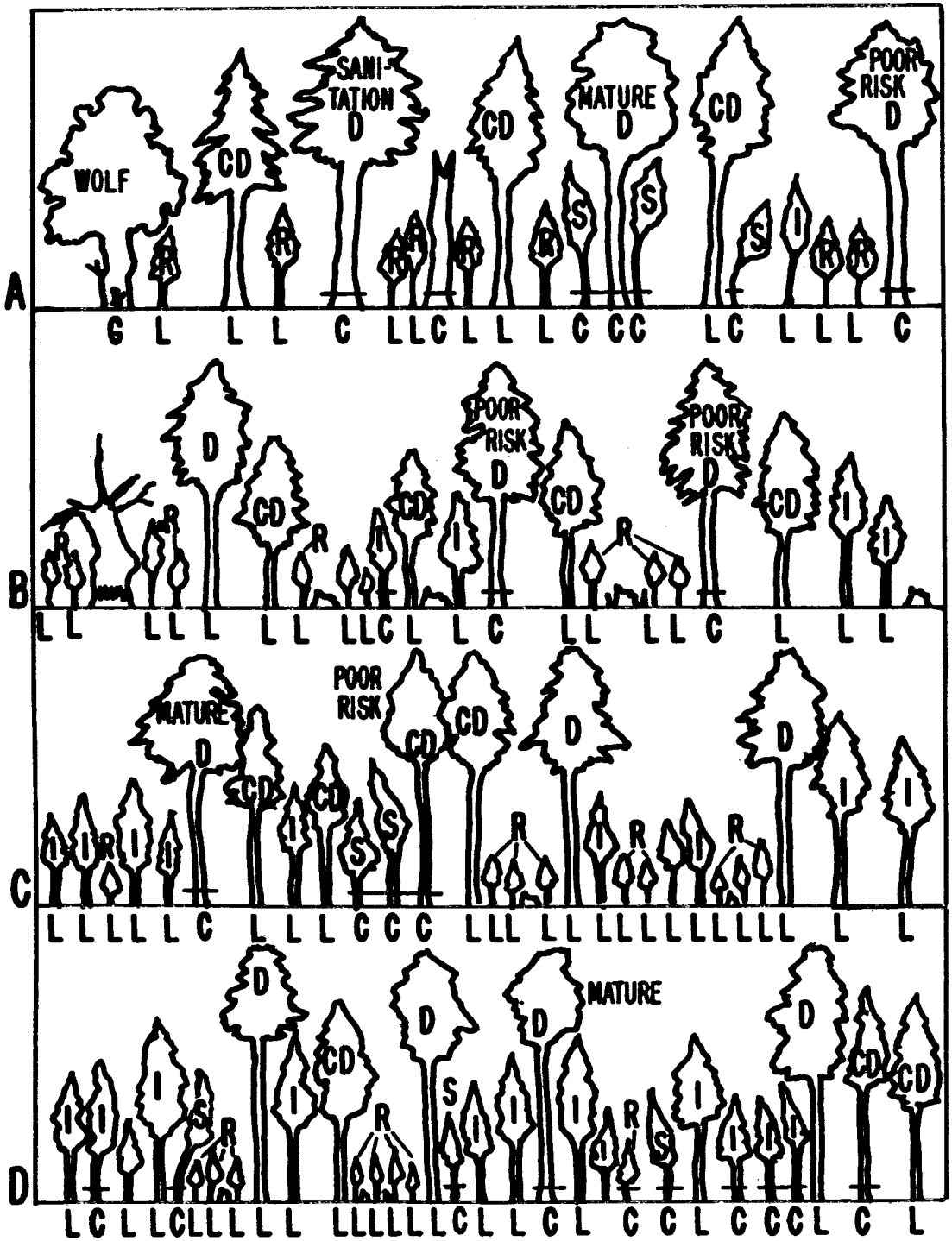
4–1.1. Silviculture is, generally, the science and art of growing and tending forest crops, based on a knowledge of silvics. More particularly it is the theory and practice of controlling the establishment, composition, stocking density, and growth of forests.

4–1.2. In an unmanaged forest, there is a continuous loss of valuable wood in trees that die of old age, trees killed by fire and disease, and trees unable to survive the competition for food and moisture. By applying silviculture, the volume otherwise wasted is reduced by utilization, and more trees of greater volume and better quality reach maturity.

Note: Some insect and disease problems are mentioned in this chapter. For more complete information, see chapter 9 of No. 3, appendix D.

4–2. Forest Regions.

4–2.1. Northern Region (Fig. 4–1): The principal forest cover-type groups of the Northern Region are—



A. FIRST CUT, UNDERSTOCKED, UNMANAGED, DECADENT STAND
B. SECOND CUT, END OF FIRST CUTTING CYCLE, LIGHT
C. THIRD CUTTING, END OF SECOND CUTTING CYCLE, VERY LIGHT
D. FOURTH CUT, END OF THIRD CUTTING CYCLE, MOSTLY PULPWOOD

LEGEND

C-CUT	CD-CODOM.
G-GIRDLE	I-INTER.
L-LEAVE	S-SUPPR.
D-DOM.	R-REPRO.

Figure 4-1. Forest Regions for Continental United States.

Type groups and forest cover types	Principal associated species
White-red-jack pine	White, red, jack pine; hemlock; quaking and bigtooth aspen; paper, yellow, and gray birch; red maple; and northern red, white, and chestnut oaks.
Spruce fir	Red, black, and white spruce; balsam fir; hemlock; northern white-cedar; and red maple.
Aspen birch	Quaking and bigtooth aspen; paper birch; pin cherry; red maple; and gray birch.
Maple-beech-birch	Sugar maple; beech; yellow birch; elm; basswood; ash; northern red oak; black cherry; paper and sweet birch; and hemlock.

4-2.2. Central Region (fig. 4-1): The principal forest cover-type groups of the Central Region are—

Type groups and forest cover types	Principal associated species
Oak-hickory	Black, post, scarlet, chestnut, northern red and white oaks; hickories; black locust; maples; sweet gum; yellow poplar; beech, and black walnut.
Oak-pine	In addition to the above, shortleaf, pitch, white and Virginia pines; and eastern red cedar.

4-2.3. Southern Region (fig. 4-1): The principal forest cover types of the Southern Region are—

Type groups and forest cover types	Principal associated species
Longleaf-slash	Longleaf, slash, loblolly pines; bluejack, blackjack, southern red, laurel, willow and water oaks; sweetgum; hickories; black and tupelo gums; magnolia; red maple; and bay.
Loblolly-shortleaf pine	Loblolly, shortleaf, Virginia pines; southern red, black, scarlet, white oaks; sweetgum; hickories; red maple; and blackgum.

4-2.4. Western Region (fig. 4-1): The principal cover types are—

Egelman spruce—subalpine fir
Interior Douglas-fir
Ponderosa pine
Western White pine
Lodgepole pine
Pinyon pine—juniper

4-2.5. West Coast-Region (fig. A-1): The principal cover types are Sitka spruce, Western hemlock, Western red cedar, Pacific Douglas-fir-Western hemlock, Redwood, and Ponderosa pine—sugar-pine—fir.

4-2.6. Alaskan Region. The forest of Alaska (fig. 4-2) are divided into the coastal forest of southeast Alaska and the interior forest.

Figure 4-2. Forest regions of Alaska.

4-2.6.1. The coastal forest is similar to that of the West Coast Region. It occupies a mountainous belt of high rainfall about 50 miles wide from the coast to the Alaska Coast Region. The timber consists mostly of western hemlock and Sitka spruce. Fire occurrence is low. Regeneration is by clear cutting in blocks, leaving blocks of seed trees, without slash burning. Current harvests are of virgin timber; there are no young or middle-aged stands and partial cutting is impractical. The principal cover types are Sitka spruce, Western hemlock, Sitka spruce—western hemlock, and Western red cedar—western hemlock.

4-2.6.2. The interior forest is similar to that which extends across Canada. It is composed mostly of white spruce and Alaska white birch with black spruce and cottonwoods in areas of low rainfall and permafrost. There are scattered bodies of merchantable timber, but much of the forest is classed as unmerchantable due to the extensive destruction by uncontrolled fires. Markets for local use are developing slowly. Methods of management are not yet established. Principal cover types are White spruce, White spruce—birch, Poplar—birch, and Black spruce.

4-3. Silvicultural Practices.

4-3.1. General. Each forest type must receive specific silvicultural treatment. Lack of markets for some products, high logging costs, or large proportions of low value specifies, will restrict management practices. Thinning young hardwood stands for pulpwood is impractical in some areas because of poor markets, excessive costs, or unsuitable species. However, thinning young pine stands, is a profitable practice where pulpwood is in demand as in the Southern Region. Because of these differences, it is necessary to prescribe silvicultural practices in general terms. Develop locally in each forest management plan modifications suitable to the installation. The principal practices applicable to military forests are intermediate cuttings, harvest or regeneration cuttings, timber stand improvement, and reforestation.

4-3.2. Intermediate Cuttings. These are the removal of trees from a regular stand between the time of its establishment and the harvest cutting. It is sufficient here to recognize three types:

4-3.2.1 Thinning. A thinning is a cutting in an immature stand to increase its rate of growth, foster quality growth, improve composition, promote sanitation, and aid in litter decomposition (fig. 4-3).

4-3.2.1.1. Crown thinning. Remove the least promising dominants and codominants that are competing with more promising individuals of these classes. Few, if any, trees in the lower crown classes are merchantable, but the stand will stagnate or have a high mortality if not thinned.

4-3.2.1.2. Low thinning. This type anticipates natural mortality by marking from below. Remove overtopped trees having merchantable value as well as unpromising intermediates, lower grades of codominants, and others in order to provide better growing space for the remaining dominants and codominants.

Figure 4-3. Young Southern Yellow Pine stand after thinning.

4-3.2.1.3. Mechanical thinning. **Any** thinning that selects the trees to be removed according to some simple, objective criterion, e.g., a minimum spacing of stems gauged by a stick of predetermined length (stick thinning). In planted stands, alternate trees in alternate rows or every second, third or fourth row of trees may be removed.

4-3.2.1.4. ***Selection thinning.*** Remove dominants which show wolf-tree tendencies and overtopped trees which have a merchantable value. Do not remove choice clean, slender-stemmed trees that retain sufficient crown to continue into the dominant class (fig. 4-3).

4-3.2.1.5. ***Basal area thinning.*** Basal area is an expression of area in square feet of breast-high cross section for individual trees or for unit forest area (acre, hectare, etc.) Sound judgment and experience are the best marking guides. Keep the trees of good quality in the dominant position and utilize the growing space to its full potential. Maintain. basal area as recommended for the species. Timber markers may not readily visualize the basal area they are leaving and must check from time to time by use of the angle gauge or other device for determining the basal area.

4-3.2.2. ***Improvement cutting.*** Improvement cutting is made in a stand older than the sapling stage, usually to start improvement of wild stands being placed under management. It involves the removal of only those unwanted trees which are of sufficient size to provide the material for merchantable products. Types of trees removed in addition to undesired species include: diseased trees, those mechanically injured, unthrifty trees likely to die before the next cutting cycle, insect infested trees, and those of poor form (forked, crooked). Improvement cuttings and thmnings in a compartment are usually concurrent operations.

4-3.2.3. ***Salvage cuttings. These*** cuttings remove dead or injured trees to utilize them before they become worthless. Salvage timber promptly following storm blowdowns, ice damage, severe fires, or attacks of insects or diseases. If extensive areas are damaged, keep as seed trees those deemed most likley to live. It is often difficult to judge whether or not fire damaged trees will die, but in the South particularly, make the decision immediately after the fire.

4-3.3. ***Harvest cuttings. This*** is a general term for the removal of financially or physically mature trees

in contrast to cuttings that remove immature trees. Regeneration cuttings remove trees intended to assist regeneration already present or to make regeneration possible. There are four primary types of harvest cuttings:

4-3.3.1. Clear cutting. This is a technically sound, scientifically proven method for regenerating evenaged stands of timber. It may involve trees which are over-mature, diseased, or dying; or to change the species composition of the forest, or rearrange the age classes. Clearcut areas are regenerated either by natural or artificial methods. Clearcuts are usually limited in size to a maximum average of 50 acres each. They must be irregular in shape to provide optimum wildlife and other resources benefits, and should blend with contours and natural or man-made features.

4-3.3.2. Seed tree method. Seed tree cutting is the removal of all trees except for selected seed-producing trees of the featured species. Seed tree silviculture is of value on military installations when areas of forest must be cleared for use as new firing ranges and impact areas, motor parks, and bivouacs and the period of use may be for 10 years or less. Seed trees left during that period may produce seedlings of desired species which will result in a new timber crop after the period of other use is over. Seed tree value is indicated by the number of seedlings around a tree (fig. 4-4). The seed trees may be left standing singly, or in groups of 6 to 10 if soils or species favor windthrow. If groups are used, leave 4 to 8 groups per acre in trees 8 to 12 inches in diameter.

4-3.3.3. Shelterwood. The basic principle of the shelterwood system is the gradual removal of the timber crop by a series of partial cuttings over a period which is a fraction of the rotation, but long enough to obtain the desired reproduction. It is a modification of the seed tree method, using large numbers of seed trees rather than a few. Shelterwood is one of the more complex methods of harvest cutting and is best applied to even-aged stands. There are three stages to shelterwood harvest cuttings:

4-3.3.3.1. Preparatory cutting. To prepare for reproduction, cut below the dominant and codominant stand and remove 25 to 40 percent of the trees. The remaining trees grow better crowns and become more windfirm and decomposition of the litter is hastened. If cutting is too heavy, grasses and weeds may move in. The preparatory cutting (one or more) is unnecessary if thinning is practiced at regular intervals.

Figure 4-4. Longleaf pine seed trees.

4-3.3.3.2 ***Seed cutting.*** Make only one seed cutting **to** provide reproduction and remove 25 to 50 percent of the remaining stand. This cutting is made just after the seeds mature in a good seed year. Logging serves to work the seeds into the humus and mineral soil. Remove smaller trees, those of relatively low vigor, and those of very large size which would destroy too much reporduction if allowed to remain until the "removal cutting.*'

4-3.3.3.3 ***Removal cutting.*** This involves the remaining old trees in one or several operations, the last of which is the "final cutting" which may not be made for many years.

Note: Pure shelterwood does not provide the most ecnoomical processes of forest management. As the situation requires, combine the various steps each time a scheduled cutting cycle is marked.

4-3.3.4. ***Selection.*** This method calls for the removal, annually or periodically, of the trees which have reached rotation age. The theoretical selection forest is all-aged with proportions of each age class from 1 year old to rotation age. Actually, this condition seldom exists, but practical application of this type of cutting may be modified to fit local conditions. For best results, harvest cutting, thinning, and improvement cutting are combined in one operation. Each area is cut over once every cutting cycle. The openings made should be of sufficient size to meet the reproduction needs of each species.

4-3.4. Timber Stand Improvement. This is, broadly, the release of young trees of desirable species, generally under 4 inches DBH, from the competition of brush and overtopping by undesirable tree species. It differs from the other described types of silviculture in that the trees removed are unmerchantable for one reason or another.

4-3.4.1. Timing. Accomplish the work before the competition destroys the ability of the desirable trees to recover.

4-3.4.2. Types (or kinds). Timber stand improvement (TSI) is a term used to identify various silvicultural management practices designed to improve the vigor, stocking, composition, productivity, and quality of forest stands on military installations. These practices include:

4-3.4.2.1. Cleaning. A cutting made in a young stand, not past the sapling stage, for the purpose of freeing trees from other individuals of similar age but of less desirable species or form which are overtopping them, or likely to overtop.

4-3.4.2.2. Liberation. A cutting made in a young stand, not past the sapling stage, for the purpose of freeing the young trees from older individuals that are overtopping them.

4-3.4.2.3. Pre-commercial thinning. A thinning of a young stand where removed trees are not of operable value.

4-3.4.2.4. Release. A comprehensive term which includes cutting operations of the cleaning and liberation types.

4-3.4.2.5. Pruning. Good sites are a prerequisite for pruning. Trees in understocked stands and in plantations do not prune themselves as a rule. Those in dense stands prune naturally while the tree diameters are small. Pruning of small trees, whether naturally or by mechanical means, will improve the quality of timber produced. However, the expense is not justified for all species. Conifers that will produce high-quality products and a limited number of special product hardwoods may benefit from pruning. Hardwood limbs over 2 inches in diameter should not be pruned. High value in such species is usually associated with large size and clear wood (no knots). Such trees may require wide spacing and several prunings. Pruning should be limited to preselected final crop trees.

4-3.4.2.6. Sanitation. A cutting made to remove dead, damaged or susceptable trees essentially to prevent the spread of pests or pathogens and thus promote forest hygiene.

4-3.4.3. Procedure or methods of accomplishing TSI. Use the following procedures to control undesirable trees and vegetation.

4-3.4.3.1. Chopping. Useful when the tree, shrub or vine can be removed by less than four blows of a sharp ax. Include trees, shrubs and vines of larger diameter when chain saws are available. Followup treatment of the stumps with silvicide is desirable to control resprouting.

4-3.4.3.2. Girdling. Completely sever the bark and cambium layer and cut into the outer sapwood at least one-half inch for the purpose of killing the tree by preventing passage of nutrients or by admitting toxic materials. Girdling may also be done by:

4-3.4.3.2.1. Hacking or frilling. A single line of overlapping downward axe cuts, leaving a frill into which silvicides may be applied.

4-3.4.3.2.2. Double hacking. Girdling by means of a double frill cut around the tree and the removal of the chips between them.

4-3.4.3.2.3. Notching. Ringing the tree with notches cut or sawn well into the sapwood.

4-3.4.3.2.4. Stripping. Peeling off a band of bark completely around the tree.

4-3.4.3.3. Silviciding. Treatment using silvicides is more effective than girdling. Silvicides must be applied immediately after cutting for effective control of sprouting. Silvicides are pesticides and thus require application by certified personnel, or under their supervision. Observe strict safety precautions and clean equipment carefully after each use. Once equipment has been used to mix or dispense any of the chemicals, do not use it for any other purpose as even the best washing may not remove the chemical. The "Herbicide Manual for Noncropland Weeds" (app D, No. 2) provides guidelines for handling, mixing, applying and storage of herbicides. See appendix D, No. 4 and Chapter 11 and 14 of appendix D, No. 3 for container label, safety rules, and personnel certification requirements for compliance to EPA and state regulations. Consult the appropriate military command agronomist/forester or specialists from forest experiment stations, agricultural extension service and state forestry or environmental departments for specific current recommendations on chemical and rate of application. Some methods of applying silvicides are:

4-3.4.3.3.1. Basal. Application of granular herbicide at the base of trees, shrubs or vines, or liquid form usually mixed in diesel or fuel oil applied by low pressure sprayer (less than 30 PSI) completely covering the bark around the bole or stem and root crown to an 18 inch height.

4-3.4.3.3.2. Cut stump. Application as in paragraph 4-3.4.3.3.1. above of granular or liquid form to freshly cut stumps or stubs. Treatment immediately after cutting must be done for good control of sprouting.

4-3.4.3.3.3. Girdling. Application of liquid herbicide mixed in diesel or fuel oil to girdled trees, axe frills or hacks using squirt cans or low pressure hand sprayer.

4-3.4.3.3.4. Injection. Application of full strength or only slightly diluted herbicide through bark cuts into the sapstream of the tree using a tool such as a tree injector or hypo-hatchet. A series of injection cuts are made around the tree rather than complete girdling.

4-3.4.3.3.5. Mist blower. Application of low volume, high concentration herbicide spray mixture primarily for releasing conifers from competition of low value, undesirable hardwood species.

4-3.4.3.3.6. Aerial. Application of low volume, high concentration herbicide using specialized boom nozzle equipment attached to helicopter or airplane. Used primarily for release of conifers from competition of low value, undersirable hardwood species.

4-3.4.3.4. Prescribed burning. This is an economical procedure for reducing competition of undesirable broadleaved brush and tree species. Do not use it where hardwood species are the principal crop.

4-3.4.3.5. Mechanical. Use of a land clearing machine, brush chopper, pusher bar equipped tractors, and other equipment to mechanically thin or release selected crop trees in young dense stands, or planations, or unmerchantable size.

4-3.5. Reproduction.

4-3.5.1. Natural seeding. This is normally considered to be the most economical means of forest regeneration, if seed of the desired species is or will be abundant within a year or two of the time scheduled for establishment of reproduction. Most species do not produce a satisfactory crop of viable seed annually. If these variables plus loss of growth time can be tolerated, many of the coniferous species may be reproduced by natural seeding. Procedures will vary by species and geographical region, but the following guidelines may assist in successful regeneration:

4-3.5.1.1. Schedule a regeneration cut (seedtree or modified shelterwood) so that harvest is completed during the year of anticipated good seedfall, with sufficient time allowed so that seedbed is ready prior to actual seedfall.

4-3.5.1.2. Leave sufficient seedtrees per acre, in accordance with successful experience in the particular geographical area for the desired species (see paragraph 4-3.3.2., above).

4-3.5.1.3. Prepare seedbed as described below (Note : para 4-3.5.1.3.2. and 4-3.5.1.3.3. are common to southern pine stands).

4-3.5.1.3.1. Log with tractors so that skidding operations expose mineral soil to serve as a seedbed.

4-3.5.1.3.2. Burn the area to be regenerated just prior to logging to remove all excess litter, fuel, and debris. Usually this burning is accomplished during the winter prior to logging operations. This materially assists in insuring satisfactory scarification during skidding operations.

4-3.5.1.3.3. If the area has already been cut back to a seedtree or modified shelterwood stand, and small diameter undesirable hardwood species are invading, a hot prescribed fire during the summer period to seedfall may assist in reducing hardwood competition.

4-3.5.1.3.4. If the processes suggested in paragraphs 4-3.5.1.3.1. and 4-3.5.1.3.2. above are not feasible, disking the area with a tractor-drawn bush and bog harrow or rolling drum chopper may enhance chances for a successful seed catch. If the area has already been cut back to a seedtree or modified shelterwood stand, disking or roller-chopping should be done during the summer preceding a seed fall and final harvest cutting.

4-3.5.2. Coppice. This is a method of renewing the forest by sprouts. The value or importance of coppice as a method of forest regeneration has been traditionally underestimated. Much of the hardwood natural regeneration in eastern forests is by sprouting. Single sprouts originating from small stumps are often mistaken for seedling origin. Therefore, in some comparisons of sprouts versus seedlings, the best sprouts may often be erroneously considered seedlings. Stump sprouts have been associated with butt rot resulting from decay of the parent stem. Sprouts originating high on the stump are susceptible to butt rot. This problem is reduced by improved timber harvesting practice that leads to lower stump heights and a decrease in the high origin sprouts. Also, increased intensity of forest management includes thinning sprouts at an early age and eliminating the high origin sprouts. Coppice for applicable species should be considered with other regeneration alternatives.

4-3.5.3. Planting. Artificial regeneration of stands by planting of forest tree species is considered to be the most feasible method of: insuring adequate regeneration; determining species composition; controlling stand density; and insuring immediate restocking of depleted areas resulting from such causes as wildfires, or areas cleared for military use and subsequently abandoned. The use of genetically superior planting stock permits wider spacing of seedlings, which results in a forest environment more compatible with military training; provides a generally more productive wildlife habitat; permits prescription burning where applicable at an earlier age; and produces more rapid tree growth.

4-3.5.3.1. Restrict planting to lands that do not

exhibit adequate natural stocking or which have been so extensively invaded with advanced reproduction of inferior species that natural regeneration of desirable species is not feasible or too costly.

4-3.5.3.2. Plant lands that are suitable for the growing of commercial timber, and not required solely for incompatible military use (e.g., tank parks, firing ranges, outdoor classrooms, etc.) Abandoned impact areas must be decontaminated prior to planting to insure safety of planting personnel and subsequent users of the area(s).

4-3.5.3.3. Soil-site factors and suitability must be carefully evaluated when planning an area for planting. Species selected for planting should have commercial value, be native to the region, and respond satisfactorily on the site(s) planned for reforestation. Introduction of exotic species, ornamentals, or species not suitable for commercial purposes is not compatible with the goals of the military forest management program.

4-3.6. Reforestation Procedures.

4-3.6.1. Site Preparation. Principles governing site preparation in advance of planting will vary from site to site and region to region; however, the most recent research findings indicate that better survival and growth of forest tree seedlings has resulted where the least possible preparation has been accomplished. Massive land clearing, to include stumping and grubbing, is neither economical nor necessary for reforestation. Preparation should be programed to allow for either hand or machine planting, whichever is the usual practice in the region. Soil displacement and translocation should be minimized. All that is usually necessary is to reduce overtopping or competing vegetation and leave the site in a plantable condition. Larger residual stems take up less room standing than when felled or pushed, and will provide nesting and food for game and non-game birds, even if later deadened in stand improvement operations.

4-3.6.1.1. Little or no preparation is required before planting abandoned fields and similar open areas, unless tall grasses and dense underbrush are present to interfere with planting machinery, or will reduce survival and growth. Remove interfering material by burning with a hot fire, prior to planting. Take precautions as for any prescribed burn.

4-3.6.1.2. Where brush is of a size or density to preclude sufficient reduction by fire, mechanical preparation is necessary. Several options are open for use, depending upon terrain and vegetation characteristics. In the Southeast, for example, excellent results are obtained with the heavy rolling drum chopper, which consists of a water-filled steel drum 7 to 14 feet long, 2 to 6 feet in diameter, and equipped with 10 to 15 sharp blades attached around the circumference of the drum. This machine is towed behind a heavy crawler tractor. A tractor blade pushes the brush and small trees over, the rolling drum chopper breaks and tears up the stems, leaving them in place on the ground. The drum chopper does not scalp the soil or result in any major soil movement or disturbance. It is not effective on stems over 5 inches in diameter.

4-3.6.1.3. Blading, shearing and windrowing or piling may be used on areas occupied by large diameter stems. The hydro-axe and mechanical tree chopper may be used where tree stems do not exceed 12 inches in diameter. Ordinary bulldozer blades may be used where the trees are scattered; however, this is not a satisfactory method where a large number of stems are encountered. In such cases the stump as well as the stem is removed, creating a disposal problem, and displacing considerable top soil. Specially designed shearing blades sever the stem at the ground line without pulling the stump and root system. This material is readily raked into windrows or piles. Only root rakes should be used for windrowing or piling, as this minimizes soil being incorporated into the windrow, results in a more compact pile or windrow, and reduces acreage lost to planting. In hilly or rolling areas, windrows should be located along the terrain contours to preclude erosion problems.

4-3.6.1.4. Heavy-duty bush and bog harrows may be used in some areas with success; however, before the area is planted, a period of several months should elapse to allow the soil to settle back to normal compaction. At least one mechanical cutter is available which features a "V" shaped blade that travels eight to ten inches underground to sever stems, followed by a bush and bog harrow section which stabilizes the blade and does some tearing and chopping of roots. This equipment produces satisfactory results in sandy soil supporting small scrub oak, but it leaves the area in rough condition, making machine planting difficult.

4-3.6.1.5. Areas treated with a rolling drum chopper usually can be burned shortly after chopping. This further reduces debris which interferes with planting equipment and helps kill or set back undesirable stems. Chopping is best done in the late spring, followed by burning in the hottest part of the summer (wildlife considerations could delay this action by 2 to 3 months). Unless windrows occupy excessive acreage, they should not be burned. This unburned debris provides excellent wildlife habitat and cover. Clean air regulations prevent open burning of debris in many locations.

4-3.6.1.6. Badly eroded or erosive sites, such as new cuts, fills, borrow areas and dunes, must be stabilized before reforestation. A good grass cover will accomplish this in most cases. After area is stabilized, tree seedlings may be planted. Machine

planting should be done with the contours to prevent further erosion. Grassing operations are not normally within the purview of reimbursable forestry operations.

4-3.6.1.7. Site preparation using specialized equipment normally lends itself better to contracting than accomplishment by in-house personnel, the exception being small scattered areas which do not lend themselves to satisfactory contracting operations.

4-3.6.2. When to plant. The planting season varies with the different regions and even within regions of the country. Normally planting is accomplished while the stock is dormant, or not later than when just starting new growth. Soil conditions must be favorable, and not excessively wet, dry, or frozen.

4-3.6.2.1. In the West, plant in the spring and continue as long as soil moisture and condition of the stock permits.

4-3.6.2.2. In the Central and Northern Regions, plant from 1 March, if ground is thawed completely, and continue to approximately 1 May.

4-3.6.2.3. In the Southern and Southeastern Regions, start planting as soon as seedlings are available from nursery sources, around 15 November if soil moisture is adequate. Planting should be completed by start of growing season for best results.

4-3.6.3. Planting stock. Use the kind, size, and age of stock best suited to local sites and climate. Seedlings are available from State Forest Service nurseries. Seedlings should be obtained from the State nursery nearest the planting sites. Geographical seed source should be included in any planting contract in order to insure that seedlings are locally adapted. Wild seedlings dug from nearby woodlands should not be used. This practice is very costly and the results are unsatisfactory. One-year-old seedlings, identified as 1-0 stock are normally used in the Southeastern States. In other areas, seedlings two or more years old (2-0, 3-0, etc), or transplants (1-2, 2-1, 2-2, etc) may be necessary, as is standard with regional use practices. Other things being equal, the older the planting stock, the higher the cost.

4-3.6.3.1. Protect planting stock in transit against overheating, dehydration, breakage, and freezing. This responsibility should be clearly spelled out in any planting contract. Normally, the planting contractor makes his own arrangements with the State nursery for obtaining seedlings. Some installations may find it advantageous to furnish the seedlings; in this case, it is the responsibility of the installation to properly transport and store the seedlings.

4-3.6.3.2. Storage instructions are normally provided by the nursery, and should be followed diligently to prevent losses from overheating, drying out, freezing, or other causes. Some nurseries use bundles which are open at the top, and these may be watered periodically. Others use sealed polyethylene lined kraft bags—care must be taken in handling to prevent tearing. Kraft bagged seedlings normally do not require watering, but seedlings must be planted within the time specified on the delivery ticket. Bags should be carefully inspected, and any found torn should be checked for dehydration; dry seedlings should be immediately discarded. If contents are not dried out, seedlings may be watered in the bag and the hole(s) secured with masking tape. If weather conditions (freezing, extreme drought, etc) preclude planting within the time specified on the delivery ticket, seedlings should be removed from bundles and properly heeled in a watered V-trench that is deep enough to permit covering the roots without curling them. When planting starts, it is imperative that the roots of seedlings be kept continuously moist with wet moss, water in buckets or planting trays, or otherwise prevented from drying out. Exposure of seedling roots to the air for as little as 1-2 minutes can render the seedling unfit to plant.

4-3.6.4. Planting procedures

4-3.6.4.1. Machine planting is the fastest and most economical means of planting seedlings, and lends itself well to contract projects. In-house personnel planting should normally be limited to small, scattered areas. This is especially true in the Southeast, where the planting season occurs when the forest fire and prescribed burning workload are at their peak, and forestry personnel cannot be committed to reforestation activities on a fulltime basis.

4-3.6.4.2. Hand planting with a planting bar (dibble), mattock, or grubhoe must be used if topography is too rough or rocky for machine planting. Hand planting is also useful for filling in areas skipped by machines, and must be used for certain high value species, such as black walnut, where survival of each tree is important. The following guidelines should be followed for hand planting:

4-3.6.4.2.1. Dig the hole deep enough to prevent bent or doubled roots (J-rooting).

4-3.6.4.2.2. Set at the same depth that the seedling grew in the nursery, i.e., with the root collar at the ground line.

4-3.6.4.2.3. Pack the soil firmly around the roots while holding the seedling in an upright position with respect to the surrounding ground level, and be sure all air pockets are eliminated.

4-3.6.4.3. Planting should allow each seedling a minimum growing space of 60 to 90 square feet, with space enough between the planted rows to drive a log truck, fire equipment, allow for subsequent cultivation for wildlife feed strips, etc. The current trend especially in the Southeastern Region is toward wider spacing between rows. This provides a faster product return, earlier prescribed burning, better access for fire control and mechanized logging equipment. Side benefits from wider spacing include more desirable wildlife habitat, and better military field training environment. The following chart indicates the number of trees required for different spacing configurations. Most state nursery tree counts are based upon sampling to establish a liberal seedling weight ratio; therefore, the actual number of seedlings received will probably be more than actually ordered, and no percentage add-on is required:

Space of plants	*Trees per acre*	*Square feet/tree*
6 ft. in rows 10 feet apart	726	60
6 ft. in rows 11 feet apart	660	66
7 ft. in rows 9 feet apart	691	63
7 ft. in rows 10 feet apart	622	70
7 ft. in rows 12 feet apart	518	84
8 ft. in rows 8 feet apart	680	64
8 ft. in rows 10 feet apart	545	80

4-3.6.5. Direct seeding. Direct seeding of forest tree species on military reservations has met with varying degrees of success, ranging from excellent to total failure. Soil-site relationships are more critical than with planting, and the variables of drought and excess rainfall during the sowing period have a more devastating effect. The greatest advantage to direct seeding is a much lower cost per acre, especially where large areas are involved. In the event of total failure, the area may be seeded a second and possibly a third time before per acre cost equals or exceeds planting costs. It must be considered; however, that a failure also results in a 1 year loss of growth, and may add the requirement of site re-preparation, with a corresponding increase in cost. Direct seeding should be considered only after weighing all variables. Consult with the nearest Forest Service Experiment Station, the state Forester and commercial forest managers who have met with consistent success, to obtain the latest recommendations. Compare their site relationships to the installation situation before proceeding. The following general guidelines will apply:

4-3.6.5.1. Obtain fresh tested seed from a reliable source, with the specification that it must be treated to repel rodents, birds, and insects. Request the nearest Forest Experiment Station or State Forest Seed Laboratory to provide their latest recommendations for developing contract specifications. Seeds of some species may need refrigerated storage. Seeds subject to delayed germination (more than 14 days) may need to be soaked, stratified, scarified, or acid-dipped. Requirements for specific species will be covered in detail in research papers. In some cases, such as black walnut, adequate seed sources may be available on the installation, and although these trees from old homesites are not necessarily genetically superior, they may provide an adequate supply of seed for limited local use. Black walnut seed is heavily susceptible to pilferage if planted in the fall, but may be stratified during the winter in a sawdust pit, and set out in the spring just as the nuts begin to sprout. Again, consult with a reliable source on proper procedures.

4-3.6.5.2. Distribute the seed over the area by one of the following methods:

4-3.6.5.2.1. Hand broadcasting is suitable for very small areas only. It is the most expensive method since distribution is uneven and more seed than necessary is used.

4-3.6.5.2.2. Cyclone type agricultural seeders are economical for areas of 10 acres or more. Speed of travel and spacing are predetermined by calibration trials in order to space the desired number of seed evenly over the prepared ground.

4-3.6.5.2.3. Aircraft (fixed or rotary wing) for direct seeding may be available on the installation, or by contract from agricultural flying services (crop dusters and commercial seed applicators). For large prepared areas, this method is the cheapest on a per-acre-basis; approximately 1000 acres can be seeded per day. The installation may have to provide ground personnel under the terms of the contract.

4-3.6.5.2.4. Seed drills are practical where soil and terrain will allow tractor travel in a safe unimpeded manner. With this type of equipment, the seed is planted in shallow plowed furrows based on calibration tests or reference charts available from local experiment stations.

4-3.6.5.3. The rate of application will vary species by species, according to the number of seed per pound, and germination percentage. Typical application rate for aerial seeding of longleaf pine would be 3 pounds per acre, with an average seed count of 4200 clean seed per pound, or 12,600 seeds per acre. Douglas-fir, on the other hand, contain approximately 42,000 seeds per pound. It is imperative, therefore, to consult proper technical sources for data applicable to the species and site.

4-3.6.5.4. Seeding must be done during the proper season for the climatic zone and according to the tree species used.

4-3.6.5.5. Pines and seeds of a similar size shold be covered to approximately 1/8-inch. Heavy seeds, which are dibbled in individually, such as acorns and

walnuts, should be planted at a depth equal to the width of the seed being planted.

4-3.6.6. ***Performance rates.*** As a basis for calculating labor and equipment requirements for planting, estimate 300-500 trees per man-day in holes in clay soils and on rough or rocky steep terrain, 800-1000 trees per man-day on sandy soils and level land, using hand labor. Machine planting with tractor-drawn planting machine of medium to heavy-duty size will average 1500-2000 trees per machine-hour. Use of small crawler tractors equipped with a "V" pusher (fig. 4-5) will materially assist in maintaining an adequate performance rate and insure better planting results. The use of "V" pusher should be specified in all contracts where machine planting will be done on other than open abandoned fields where no prior preparation, other than burning of grass is required.

4-3. 7. ***Tree Classification.***

4-3.7.1 Hardwoods are native trees that have broad leaves and, generally shed their leaves prior to each growing season. Examples: oak, ash, maple, magnolia, elm, hickory, and aspen. The term has nothing to do with the physical hardness of softness of the wood.

4-3.7.2. Softwoods are known also as conifers. All native species of softwoods have needlelike or scalelike leaves and bear their seed in cones. With the exception of two genera, Larix (larch) and Taxodium (baldcypress), softwoods are "evergreen."

4-3.7.3. Old growth refers to trees and stands that have reached or passed maturity. In addition to age and size, the principal characteristic is relatively slow growth due to intense competition for sunlight andmoisture.

4-3.7.4. Second-growth trees and stands are those that have come up naturally after some drastic interference (e.g., wholesale cutting, serious fire, or insect attack) with the previous forest crop.

4-3.7.5 Crown classification is valuable as a gauge of silvicultural behavior and the current position of trees in the stand. The following system distinguishes the seven classes which are standard for all Department of Defense military reservation timber:

4-3.7.5.1. Dominant trees extend above the general level of the canopy.

Figure4-5. V-pusher equipped tractor with heavy duty tree planter attached.

4-3.7.5.2. Codominant trees are not as tall as the dominants, but receive excellent overhead light, have full crowns, vigorous growth, and show no danger of being crowded out by the dominants.

4-3.7.5.3. Wolf trees are distinguished by a widespreading crown that occupies more than its fair share of the growing space, and limbs that are relatively larger and often more numerous. The lumber quality of the stem is poor to unmerchantable because of the large knots resulting from the many oversized limbs.

4-3.7.5.4. Intermediate trees have slender crowns that occupy smaller openings in the canopy, receive only a limited amount of direct sunlight, and will probably be crowded out by the dominants or codominants before reaching maturity unless released by death or removal of the dominating trees.

4-3.7.5.5. Suppressed trees are definitely below the general level of the canopy and receive no free overhead light. These trees will die before the end of the rotation, or will remain stagnated making no appreciable height or volume growth.

4-3.7.5.6. Isolated trees stand at a distance from other trees, have a greater height than the average dominant, and are not properly classified as wolf or reproduction.

4-3.7.5.7. Reproduction is a naturally established tree seedling or sprout having a diameter of less than 2 inches DBH and an age of less than 30 years.

4-3.7.6. Age classification is useful in type mapping (pure stands are frequently typed by age classes), volume table construction, and reports. Examples of age classification classes are—

Inclusive ages	Age classification
0–10	5
10–20	10
20–30	20
30–40	30

4-3.7.7. Diameter classification is useful for volume table construction, development of fire damage tables, stand descriptions, and other purposes. For example, volume tables are usually developed by 1- or 2-inch-diameter classes. The 1-inch classes are generally 4, 5, 6, and up with each group including all trees having diameters, inclusive, of 3.6 through 4.5, 4.6 through 5.5, and so on. The 2-inch classes are generally 6, 8, 10, 12, and up, with each group including all trees having diameters, inclusive, of 5.1 through 7.0, 7.1 through 9.0, 9.1 through 11.0, and so on.

4-3.7.8. Form class is based on diameter breast high (DBH), total height, and taper of bole. It is desirable to classify trees according to form in order to develop greater accuracy in volume tables. Theoretically, all trees of like form class should contain the same volume, regardless of species or locality. In practice this is not quite true due to differences in volume resulting from the kind and degree of utilization (sawtimber or pulpwood, and varying top utilization diameter) and type of volume table desired (board foot, cubic foot, peeled cord, or rough cord). Volume tables based on form class are in widespread use.

4-3.7.8.1. Computation. Form class is expressed as the percentage ratio between the diameter, inside bark, at the top of the first 16-foot log; and the diameter, outside bark, at breast height (DBH). For example: a tree whose first 16-foot log has a scaling diameter (inside bark) of 15 inches and a DBH of 18 inches has a form class of $(15 \div 18) \times 100$, or 83.3 percent, which in practice is referred to as "form class 83."

4-3.7.8.2. Minimum form class. Form class below 65 should be considered for uses other than lumber production. Swell-butted species, such as cypress and tupelo, will have a very low form class based on DBH. To avoid this, the diameter of swell-butted trees should be measured high enough on the tree to provide a realistic form class.

4-3.7.9. Botanical Classification. Trees may have more than one common name, varying with locality. "Pitch pine" may be coulter pine in California, slash pine in South Carolina, or longleaf pine in Louisiana. To avoid confusion and insure accurate identification of trees and other vegetation, scientific names have been assigned to each species and variety together with standardized common names for everyday use.

4-3.7.9.1. The scientific name has two or more parts: First, the generic name; second, the specific name. Sometimes it is necessary to add a varietal name. The generic name is always written first and is capitalized. The specific and varietal names usually being with small letters. For example: all true maples have the generic name *Acer.* The specific name for sugar maple is *saccharum.* These two words, *Acer saccharum,* identifies it as sugar maple.

4-3.7.9.2. See appendix D, No. 1 for "Check List of Native and Naturalized Trees of the United States."

APPENDIX A

NATURAL RESOURCES MANAGEMENT PLAN*

OUTLINE FOR PART III—FOREST MANAGEMENT

A-1. Description of Items Inherent to Part III of the Plan

A-1.a. Forest land treatment since acquisition, including history of fires, logging, military use, and acres reforested (plant and seed).

A-1.2. Identify any wood-using industries offering markets for forest products.

A-1.3. Prepare the following information in tabular form:

A-1.3.1. Total estimated merchantable volume of sawtimber, pulpwood, and other forest products. Specify basis of estimate, e.g. one-time inventory stating percent cruise, point sampling of continuous forest inventory; also state whether accomplished in-house or by contract.

A-1.3.2. Calculated annual allowable harvest by products for next 5 years.** (Plan outline is not applicable to Air Force installations.)

A-1. (3) Years in cutting cycle.

A-1.3.4. Estimated operating cost (protection included) by fiscal year for next 5 years.** (Plan outline is not applicable to Air Force installations)

A-1.3.5. Estimated value of products to be harvested by fiscal year for next 5 years.** (Plan outline is not applicable to Air Force installations.)

A-1.3.6. Forest fire record. Tabulate information on a separate page in the following manner:

FISCAL YEAR		MANAGED FOREST AREA				IMPACT AREA FIRE REQUIRING ACTION
		NUMBER OF FIRES	ACRES BURNED	ACRES PER FIRE	NUMBER REPORTABLE	

A-2. Description of Forest Land

A-2.1. Name and describe either the distinct forest types (para A-2.2) or the land classes (para A-2.3) common to the managed forest land.

A-2.2. Show the acres in the following manner:

FOREST TYPE (NAME)	FOREST ACRES WITHIN TYPE			FOREST UNDER MGMT.
	ACTIVE IMPACT[1]	OUTSIDE ACTIVE IMPACT WITHIN SAFETY FAN[2]	NONDANGER AREA[3]	

[1] Active impact area is that area which is subject to concentrated firing or explosive demolitions. Usually timber within this area contains excessive metal contamination; this land is not classified as managed forest area.

[2] Outside active impact within safety fan includes managed forest land which can be managed with little or no possibility of excessive metal contamination. Accessibility in these areas is limited to periods when ranges and demolition areas are not utilized.

[3] Nondanger area includes acreage which is not within active ranges, explosive demolition area or range safety fans.

A-2.3. Show the acres by Land Class (See para A-2.4) in the following manner:

A-2.3.1. Commercial Forest Land (CFL) _____
- Regulated _____
- Modified _____
- Restricted _____

A-2.3.2. Non-Commercial Forest Land (NCF) _____
- Non-Productive _____
- All other acreage _____

Total Installation Acreage _____

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* Plan outline is not applicable to Air Force installations.

** 10 years for Navy installations.

(A table could be set up to record land class changes)

A-2.4. Suggested definition of Land Classes:

A-2.4.1. Commercial Forest Land—Land currently or prospectively available for timber production and capable of producing at least 20 cu. ft./acre/year of commercial forest products.

A-2.4.2. Regulated—CFL presently available for management on a planned rotational basis with minimum restrictions.

A-2.4.3. Modified—CFL that cannot be managed on a planned rotational basis but is producing commercial products that are harvestable through salvage or silvicultural operations applied for other than timber production purposes. Examples are recreation and scenic areas, buffer zones, areas managed primarily for military purposes, and wooded parts of cantonment.

A-2.4.4. Restricted—CFL that is reserved for other uses and is not available for any production such as impact areas, cleared ranges, etc. These are areas that may become available for timber purposes in the foreseeable future. Also potentially productive land that is inaccessible during plan period.

A-2.4.5. Non-Commercial Forest Land (NCF)—Land not capable of producing at least 20 cu.ft./acre/year or land permanently removed from productive status such as natural areas or permanently inaccessible areas.

A-2.4.6. Non-Productive—Land not capable of producing 20 cu.ft./acre/year including natural and man-made wetlands that will not be converted to timber production in the foreseeable future.

A-2.4.7. All Other Acreage—Improved, semi-improved, and unimproved acres (See "Inventory of Land Use" Part I Installation Natural Resources Management Plan).

A-2.5. Utilize soil survey maps, where available, to determine (interpret) forest suitability groups.

A-3. Management

A-3.1. General. Explain briefly the types of timber crops to be grown and the anticipated intensity of management with resources available.

A-3.2. Species to be Grown. Designate by common and scientific names the species including special/favored species (e.g. black walnut), which are to be grown and managed for production. Give the reason for the selection of each. Estimate for each species sawtimber and pulpwood volume currently available and include in appendix.

A-3.3. Rotation. (Approximate age of species when ready to harvest as final product.) Designate the rotation to be used for each timber species.

A-3.4. Cutting Cycle.(Interval planned between harvest.) State the number of years selected and give reasons.

A-3.5. Compartments, Cutting Units and Stands. Establish the administrative and regulatory subdivisions as follows:

A-3.5.1. One compartment for each year of the cutting cycle when practical, considering species, rotation, acreage, yield, and topography. If the military mission or management decision preclude harvesting of the compartment scheduled, then a similar acreage in other compartments may be substituted. If the acreage and yield are small, use fewer compartments or blocks and adopt a periodic cutting cycle.

A-3.5.2. Within each compartment, establish cutting units of 40 to 80 acres each with easily identifiable boundaries; mark first on a contour map and then on the ground. Within each compartment and cutting unit identify forest stands having different ages, species growth rate or potential and other differing forest characteristics. Prescribe for each stand the treatment during the next 5 or 10 year period.

A-3.5.3. Include a tabular breakdown by compartment showing approximate acreage in each category as follows:

COMPARTMENT NUMBER	MANAGED FOREST AREA (ACRES)	FOREST IMPACT AREA (ACRES)	TOTAL (ACRES)	DATE 1ST AND SUBSEQUENT HARVESTS

A-3.6. Silvicultural System. Define the practices to be used in growing and reproducing timber crop species.

A-3.6.1. General Practice Use. Specify even-aged and/or uneven-aged management systems to be used for various species managed. Discuss systems of intermediate and harvest cuttings to be employed. State planned treatment of understocked stands as well as those fully stocked.

A-3.6.2. Harvest Schedule.

A-3.6.2.1. Specify whether annual or periodic harvests are to be made and state reasons. Indicate, by products, the approximate volume to be cut during the next 5 years* and the basis for the estimate. Where more than one product is to be harvested, schedule the order of cutting according to type of product. Example: poles, lumber, ties, posts, and pulpwood.

*10 years for Navy installations.

A-3.6.2.2. Discuss the optimum volume to be made available in each timber sale considering local market conditions, management objectives and military use of the land.

A-3.6.2.2. Discuss the optimum volume to be made available in each timber sale considering local market conditions, management objectives and military use of the land.

A-3.6.3. Timber Sale Planning.
Include factors to be considered such as operable and inoperable harvest areas according to volumes in need of removal, metal contamination which may be encountered, accessability due to range firing, training schedules, or other installation activities.

A-3.6.4. Timber Marking.

A-3.6.4.1. Training. Describe personnel training to insure that markers are well qualified to recognize complex forest conditions and to select trees for marking so as to modify these conditions toward long-range objectives. Include training in recognition of age classes, site productivity for various species, tree quality, stand density, mechanical damage, disease and insect recognition and estimation of DBH and height.

A-3.6.4.2. Field Procedure. Include size of crew, duties, use of paint and colors to use, where to place marks, how to proceed to insure area coverage, product designation including size limits by product, volume estimation and recording, and volume computation from field data.

A-3.6.5. Timber Cruising and Seed Tree Marking. Describe method of cruising to determine total timber volumes by product on areas to be cleared and field procedure to be followed in marking seed trees when desirable.

A-3.6.6. Timber Harvesting.

A-3.6.6.1. Prior to all timber sales, determine if harvesting of certain areas or trees might adversely affect the installation mission.

A-3.6.6.2. Reports of Timber Availability. (Applicable to Army installations only.) Describe procedure for preparing subject reports in accordance with DA PAM 420-7 and forwarding to the MACOM for approval. A sample report should be included in the appendix. It should include timber sale volumes by product marked in each unit, description and maps of the sale area, specifications to be included in the contract and other detailed information.

A-3.6.6.3. Inspection of Sales in Progress. Sales in progress will be inspected periodically by forestry personnel. Describe inspection procedure, coordination with the District Engineer representative or Contracting Officer, and reporting of contract violations to the District Engineer representative or Contracting Officer. Monthly and final completion reports will be furnished the installation forester by the District Engineer for all timber sales in progress. These reports will include volume and value of products removed. Quarterly and annual machine run reports will also be furnished listing volume and value by contract of all products harvested during the reporting period.

A-3.6.6.4. Contract clearance reports will be submitted to the District Engineer or Contracting Officer, after final inspection of the sale area by installation forestry personnel. Outline procedure for these inspections and include such items as utilization of all marked trees and sawtimber tops, cutting of unmarked trees, removal of limbs and debris from roads and firebreaks, and minimum stump heights.

A-3.6.6.5. Timber harvested for installation use as training course material, parking lot borders, posts, range materials, etc., will be in accordance with AR 420-74/AFR 126-1/NAVFAC INST. 11015.9A/MCO P11000.8. Describe method of marking and controlling harvest of these products on installation.

A-3.6.7. Other Silvicultural Treatment. Describe the use of prescribed burning, conversion of land occupied by unmerchantable forest species to a desirable species by mechanical clearing and planting, and removal of individual undesirable tree species by herbiciding, girdling, and a combination of these methods when their use is applicable. Designate the species to be removed. Define procedures for the formulation and application of chemicals, and rules of safety. Include schedules for applying the designated treatment, the time of year, time of day, and kind of day. Locate and schedule each type of treatment on a map. Include instructions deemed essential to proper correlation of silviculture and wildlife management. Correlate prescribed burning for silvicultural treatment with burning for fuel reduction (protection).

A-3.6.8. Planting. Describe fully the planting planned annually for the next 5 or 10 years, identifying location, species and spacing to be used, acres to be planted, age of planting stock required, and include direct seeding as appropriate. Specify the time of year to plant and how to plant (hand or machine) and type of tool preferred. Explain reasons for planting (as opposed to natural revegetation) and for the species selected to plant. List sources of planting stock. Include tabulation in the following format:

REFORESTATION PROGRAMMED

FY	ACRES SITE PREPARATION REQUIRED	ACRES TO BE PLANTED	ACRES TO BE SEEDED	SPECIES	TOTAL ACRES REFORESTED

A-3.6.9. Annual Work Plan. To insure proper sequence of forest management work and to obtain funding, an annual work plan will be prepared and submitted to the appropriate military command for approval. See Annex I for suggested format.

A-3.7. Management Record System. List permanent records to be maintained on maps, aerial photos or in report form on file at the forestry office, to include the following:

A-3.7.1. Timber availablity reports for current and previous FY.

A-3.7.2. Timber sale contracts in progress.

A-3.7.3. Contract completion and release reports completed during current and previous FY.

A-3.7.4. Income summary by FY.

A-3.7.5. Cost summary by FY.

A-3.7.6. FY plantation records.

ANNEX I

ANNUAL WORK PLAN—FOREST MANAGEMENT WORK RECORD (Suggested Format)	DOLLAR PROCEEDS FROM SALES ESTIMATED THIS FISCAL YEAR $	PERIOD COVERED BY REPORT	DATE PREPARED
TO:	FROM: *(Installation)*	TYPED NAME, GRADE, TITLE & PHONE OF PERSON RESPONSIBLE FOR THIS REPORT	

LINE	JOB DESCRIPTION	JOB		WORK BY POST FORCES				WORK BY CONTRACT		EQUIPMENT ACQUISITION	TOTAL COSTS
		UNIT	AMOUNT	MAN DAYS	LABOR COSTS	MATERIAL COSTS	EQUIPMENT RENTAL	AMOUNT	COST		
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*
1	**TIMBER STAND IMPROVEMENT**	ac									
2	**REFORESTATION**										
3	Site Preparation	ac									
4	Tree Planting	ac									
5	**FIRE PROTECTION**										
6	Woodland Areas Protected	ac									
7	Firebreak Maintenance	mi									
8	Firebreak Construction	mi									
9	Pres. Burning	ac									
10	Firetowers Manned	ea									
11	Fire Suppression	ea									
12	Fire Training Classes	ea									
13	**ACCESS ROADS**										
14	Roads Maintained	mi									
15	Roads Constructed	mi									
16	**TIMBER HARVEST**										
17	Marking	ac									
18	Marking	bd ft									
19	Marking	cds									
20	Sales Inspection	ea									
21	Forest Inventory	ac									
22	Timber Survey	ac									
23	Declaration of Availability	ea									
24	**MISCELLANEOUS**										
25	Insect & Disease Control	ac									
26	Training Conferences	ea									
27	Plans	ea									
28	Equipment Maintenance	pcs									
29	Leave	hrs									
30	Other										
31	TOTAL										

See instructions on reverse side.

Instructions for Completing Annex I to Appendix A
(Annual Work Plan)

Note 1	Include only those activities (jobs) involving areas supported by reimbursable funds.
Note 2	Report costs to the nearest dollar and amounts to the nearest whole number.
Lines 7 & 8	Do not include firebreaks around perimeter of concentrated range firing impact area (i.e., the beaten zone plus the portion of the impact area in which fires frequently occur from incendiary ammunition); those along perimeter boundaries of the installation or along main traveled roads.
Line 9	Do not include prescribed burning in impact areas or burning in permanent open areas to prevent vegetative wildfire.
Line 11	Do not include fire suppression within small arms impact areas or that within storage areas, i.e., ammunition and vehicle storage areas.

APPENDIX B

TIMBER INVENTORY

B-1. Definition. Timber inventory is a field procedure that provides information concerning the timber volume of a designated area and other characteristics of the forest and land. It is a sampling process which ranges in intensity from 100 percent downwards.

B-2. Purpose and Objectives. To prepare plans for the intelligent management of forest properties, an initial inventory of all timber is desirable. Such an inventory includes the quantity and quality of forest trees, their growth, and the characteristics of the land. It should follow a land use survey in order to encompass such nonwood values as aesthetics, recreation, watershed protection, and wildlife management, in coordination with the military mission of the installation. Subsequent inventories should be made at the following times during the implementation of the forest management plan:

B-a. At periodic intervals, the volume data, timber growth, timber drain, and land use changes should be brought up-to-date.

B-b. Prior to any harvesting and sale of forest products, the volume and value of the trees to be cut should be ascertained.

B-2.3. In the event of trespass or fire, the volume and value of the trees should be determined for proper record-keeping and possible litigation.

B-2.4. In the event of sale, disposal, or exchange of government-owned lands, a timber inventory should be one of the bases for determining value.

B-3. Inventory Procedures. The first step in a timber inventory is to prepare a base map, generally at a scale of 4 inches to the mile. Topographic features such as roads, trails, railroads, water bodies and courses, improved grounds, firing ranges, impact areas, antenna fields, ammunition areas, and other areas not in the forest acreage should be placed on the base map. This data can be found and transferred from other government topographic maps and from aerial photographs.

B-3.1. Compartments. For the purpose of managing forest lands, the area should be divided into compartments. Compartments should be defined on the base map by permanent boundaries (fig. B-1). These can be natural or man-made features such as ridges, streams, roads, railroads, reservation boundaries, or other clearly defined physical lines. All compartments on the base map should be identified numerically. One compartment should be established for each year of the cutting cycle. The number of compartments established will range from five to ten, depending upon the rate of growth (the cutting cycle should be established as ten years when not determined by other methods). The compartments should be approximately equal in area, if feasible. Legal subdivisions should be used if they are convenient. Military subdivisions are useful in some instances. A timber type map at a scale of eight inches to the mile should be prepared for each compartment. Various timber types can be transferred to the compartment map from aerial photographs and supplemented with data from a follow-up timber cruise. Supplemental data should include stand density, size classes, age classes, subspecies, site index, and forest suitability determinations.

B-3.2. Cutting Units. Individual compartment maps showing timber types should be further divided into cutting units, 40 to 80 acres in size. The cutting units are used as record units for timber inventory, timber marking, cultural operations, and timber sales. Cutting units should be identified by numbers, starting a new series for each compartment (fig. B-1). In some systems of management (Air Force and Navy), the stand, or block, is used as the basic record unit rather than the cutting unit.

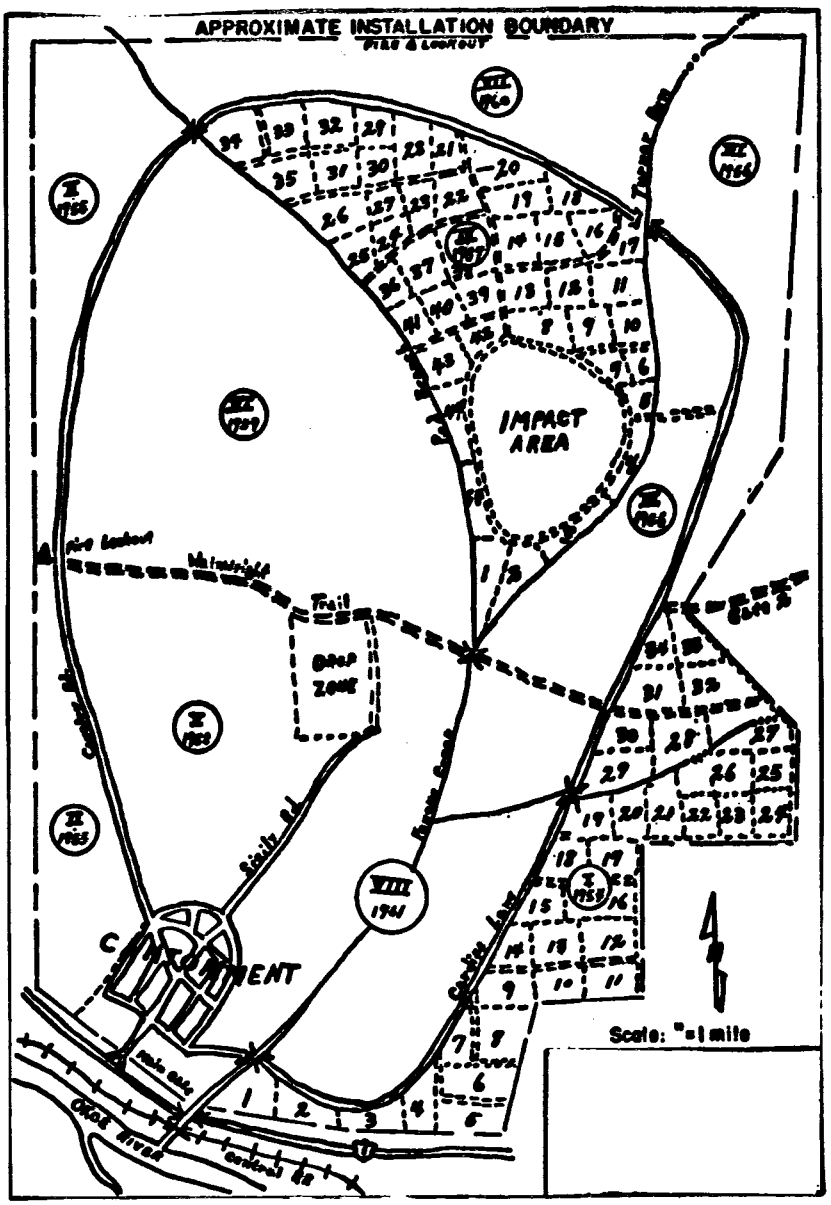


Figure B-1. Compartments and cutting units/stands or blocks

B-3.3. Aerial Photography. Timber types and identification, as well as stand condition classes, can best be delineated and transferred to a compartment timber type map by the use of aerial photography. For the purpose of type mapping, 9" × 9" contact prints should be obtained for stereoscopic examination (fig. B-2). Black and white pancromatic and infrared film are used for most government photography. If military photographs are too old, more recent photographs can be obtained from other government sources: the Agricultural Stabilization and Conservation Service, Forest Service, and Soil Conservation Service of the U.S. Department of Agriculture, and certain state forestry agencies. Maps showing areas covered by aerial photography in the United States are available upon request from the U.S. Geological Survey. If supporting military aircraft are available, the installation's forests can be flown and photographed, using false color film. This film, known as "Color Infrared, Camouflage Detection, Kodak Aerocrome Infrared Type 2443", has proven the most satisfactory for forest type identification and classification.

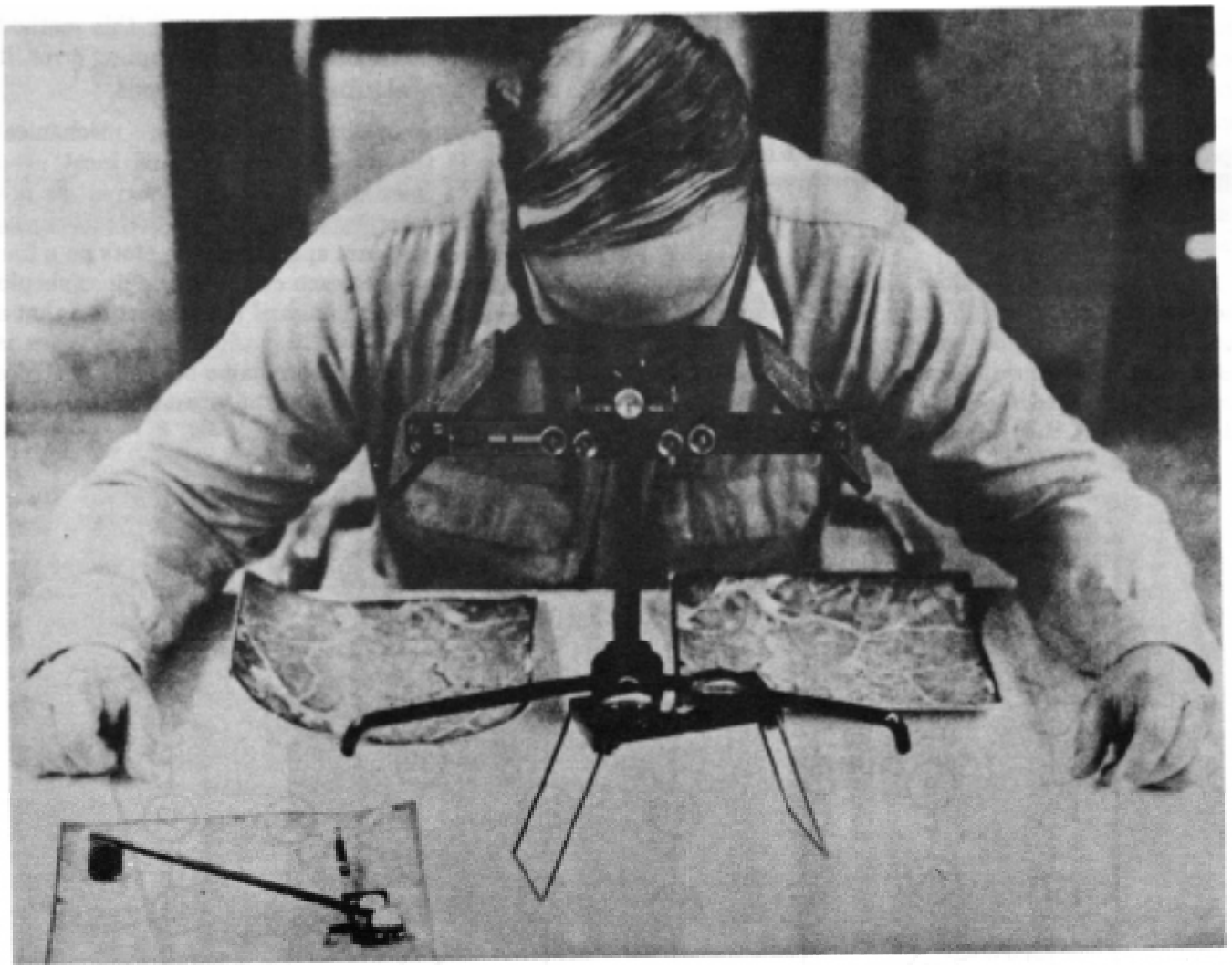


Figure B-2 Examining aerial photographs under stereoscope.

B-3.4. Photo Interpretation and Mapping. **To delineate the various timber types and classifications, the delineation lines must be drawn under a stereoscope. After the types have been delineated, the desired detail can be transferred toa compartment map by using a vertical sketch master.**

B-3.5. *Suggested System of Type and Size Classes.* A standardized symbol system for various classifications and information about each timber type is shown in Table B-l. If timber type data is to be processed by machine methods, the various types are given individual numbers. A numbering system or code is contained in the Forest Survey Handbook available from the regional offices of the Forest Service. The photo interpreter may not be able to differentiate each classification on the aerial photograph the classification can be completed and corrected, if necessary, from data obtained during the timber cruise. In addition to the timber types and classification, noncommercial forest land should also be delineated and transferred to the timber type map. Forested areas which may require special management treatment are: recreational areas, natural or unique areas, threatened and endangered species habitats, water bodies and courses, wetlands, protective strips, and roadside aesthetic strips.

B-4. Sampling.

B-4.1. Sampling Design Timber **cruising is essentially a sampling process. The intensity of sampling is determined by the size of the area being inventoried, the purpose of the inventory, and the degree of accuracy needed. Another factor that influences the degree of sampling is the variability of the timber as to condition, size, density, and uniformity of stocking. Since timber is becoming increasingly valuable, the percentage of error of atimber cruise should be kept low. For purposes of management planning, a sampling error of 10-15 percent is allowable. When timber is cruised for the purpose of a clear-cut timber sale, the results should**

fall within a five percent allowable error. With the exception of 100-percent sampling in which all the trees are measured, the sampling area may be a circular plot, strip, or point sample. The most common plot sizes used in inventorying are one-fourth, one-fifth, and one-tenth acre. There are three systems of sampling design: random, systematic, and stratified.

B-4.1.1. Random. Random sampling is a system where the locations of the sampled plots are established by random selection. An overlay grid is superimposed over the map or photograph of the area to be cruised. Once the number of sample plots is determined, they are located on the grid by using a table of random numbers. Although this method facilitates the computation of the sampling error, it is not as practical to use as other methods.

B-4.1.2. Systematic. Systematic or mechanical sampling is the most practicable and most used system in timber cruising. The sampling pattern is a definite grid, whereby the lines of plots (cruise lines) are the same distance apart, and the plots on a line are equidistant from each other. Cruise lines should be run across the drainage of the property so that a good cross section of the various timber types is sampled. This method eliminates bias and provides a more uniform coverage of the forest (fig. B-3).

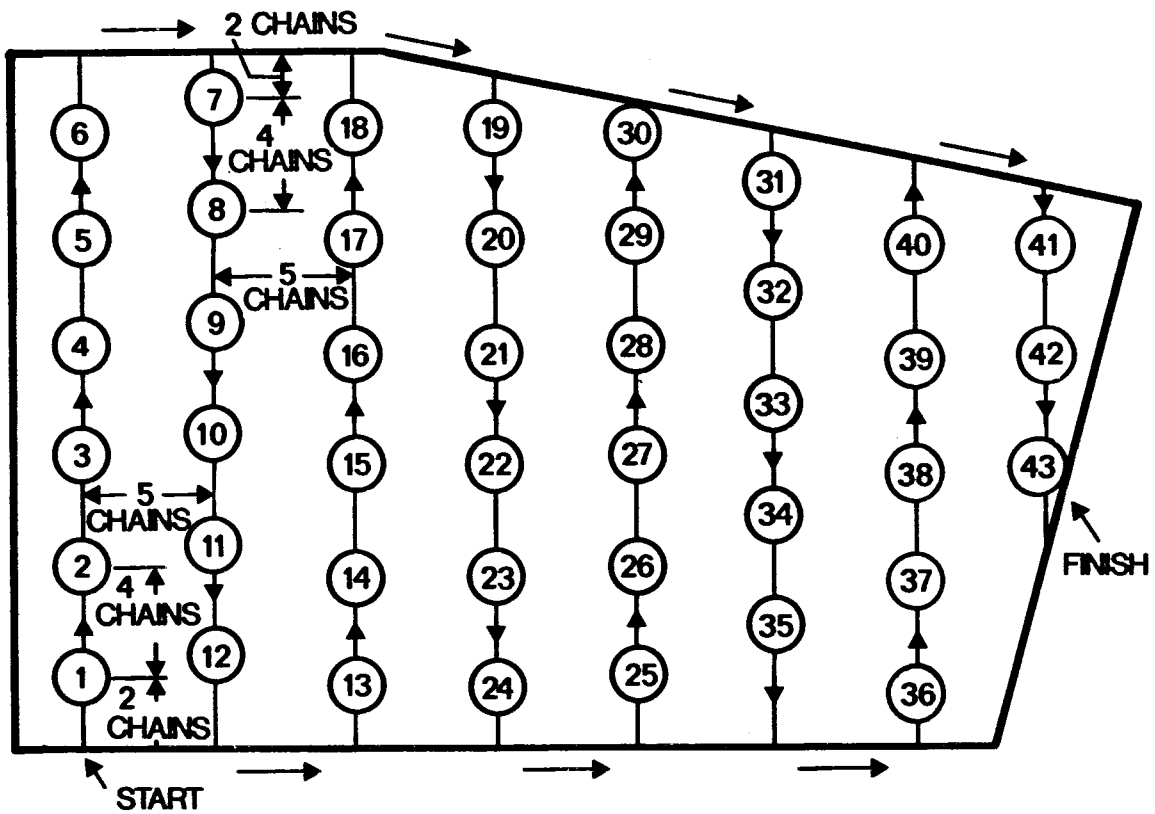


Figure B-3. Diagrammatic plan for a 10-percent systematic line-plot cruise utilizing one-fifth-acre circular samples.

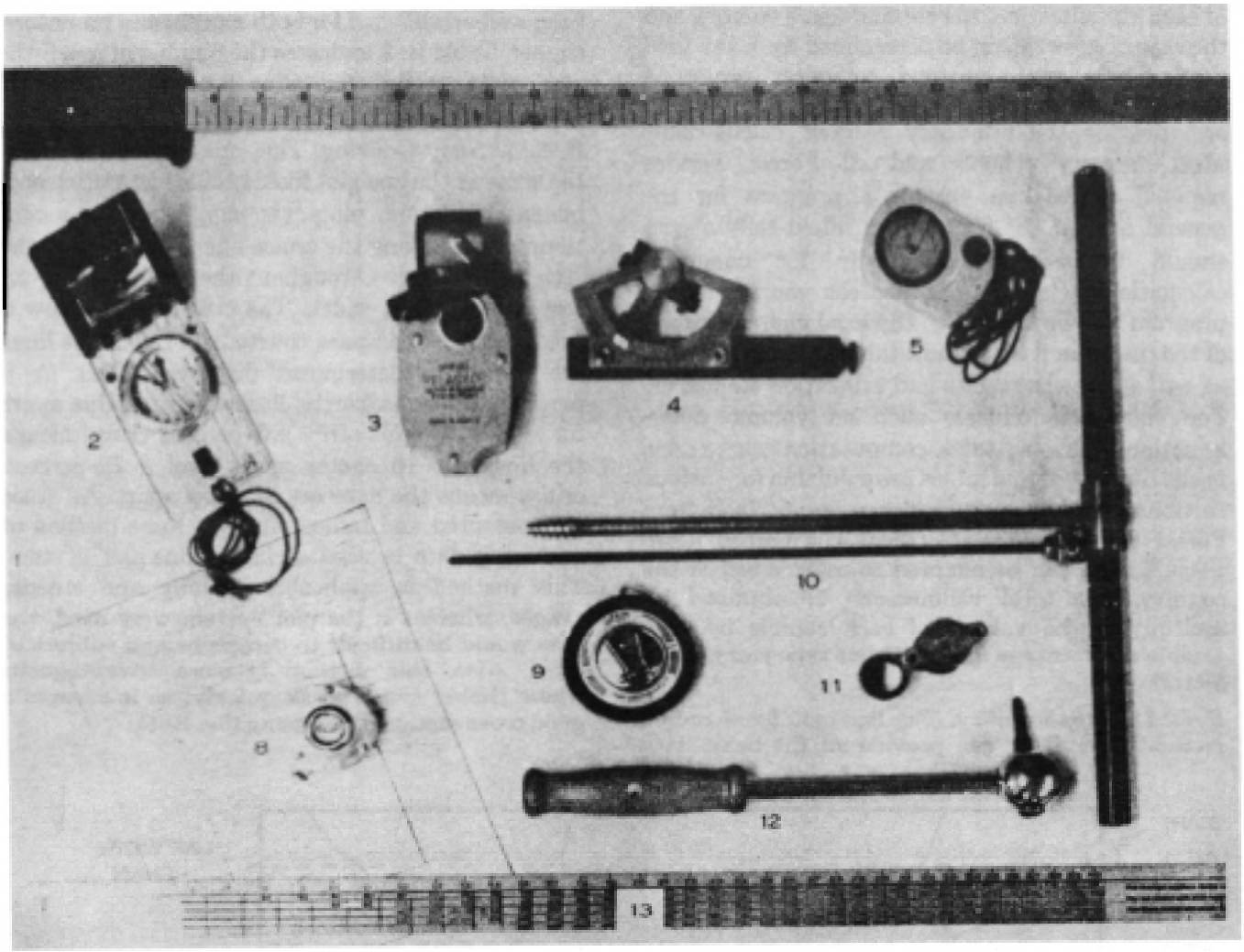
B-4.1.3. Stratified. Stratified sampling combines the features of aerial and ground estimates. Photographs or type maps are used for area determination of each major timber type. The number of sample plots to be measured on the entire tract is predetermined. The plots are then located on each predominant timber type by proportional allocation. The distribution of the plots is in proportion to the area of each type. All field plots taken on each type should be located by random selection, both on the photographs and type map, and then on the ground.

B-4.2. Methods of Sampling and Inventory. When the intensity of the timber cruise and the sampling design have been determined, one of the four methods of sampling can be chosen: fixed radius plots, strip cruising, variable plot or point sampling, and three-P sampling.

B-4.2.1. Fixed Radius Plots. Line-plot cruising is the systematic measuring and tallying of all trees on a series of sample circular plots laid out in a grid pattern. The cruise lines are run at uniform spacing, and the plot centers are located at predetermined intervals along each cruise line. Plots are usually one-fifth acre in size (with a 52.7-foot radius). Sometimes a one-tenth-acre plot (with a 37.2-foot radius) is used for dense pole and smaller size timber. The distances between cruise lines and

between plots are predetermined by the percent or intensity of the sample.

B-4.2.1.1. Field Procedure. The first step in the field is to determine the compass direction of the cruise lines so that the topography will be crossed by the lines. Running the line parallel to one side of the tract (compartment) is desirable, if possible. Distances between plot centers are located by chaining or pacing. Once a plot center is located, the perimeter must be located by chain measurement of the plot radius (fig., B-4).



1. *Calipers for diameter measurement*
2. *Compass*
3. *Relaskop*
4. *Abney level*
5. *Clinometer with range finder*
6. *Prism*
7. *Tally sheet*
8. *Tally meter*
9. *Diameter tape*
10. *Increment borer*
11. *10X hand kns for ease in reading growth rings*
12. *Increment hammer*
13. *Tree scale stick*

Figure B-4 Forestry instruments used in inventory and harvest calculations.

B-4.2.1.2. Data-Gathering.

B-4.2.1.1.1. Measure the Diameter at Breast Height (DBH) and tally all trees with a DBH of 5-inches and over; estimate merchantable height; and classify as to species and utilization (e.g., pulpwood, sawtimber, poles, piling and peeler logs).

B-4.2.1.2.2. Record the cut or leave trees for **a** Timber Stand Improvement (TSI) cut or a first partial harvest.

B-4.2.1.2.3. Bore and record sample trees of different sizes (2 to per plot) to determine age, rate of growth, merchantable and total height, from which site classification as well as future growth can be ascertained.

B-4.2.1.2.4. Make a reproduction count of trees 4 inches in diameter and smaller on an inner one one-hundredth-of-an-acre plot (with an 11.8-foot radius).

B-4.2.1.2.5. Record observation of timber types and ground conditions.

B-4.2.1.3. Volume Determination. The total volume of each classification, the cut-and-leave volume, and the rate of growth can be determined from the field data. There are numerous computer programs already designed and available that can simplify and provide the necessary readout calculations. Most forestry schools and all Forest Service regional offices can provide a program for the general area of the installation. Field tally sheets should be designed especially for computer calculations. Contact the nearest source, as its program will be slanted to the local characteristics of the timber and the volume tables used in the area, as well as growth results and utilization standards. For small-area cruises, such as volume determination for timber sales, computation can be done in the office. Volume tables are available for various sections of the country and can be obtained from Forest Service regional offices. The Girard Form Class Tables can be adapted to most areas of the country. The total volume can be obtained by multiplying the volume of each sample by that sample's percentage of the timber type (conversion factor).

B-4.2.1.4. Applicability. The line-plot fixed radius method of cruising can provide all the basic data needed for preparation of an overall timber management plan. It is a simple method to use and can be applied to large- or small-area inventories. Because there is a record of data for each individual plot, it is a simple matter to extract the volume and other information for each individual timber stand or type. The sampling accuracy of this method has been well-established for both mature and immature timber. Table B-2 indicates the number of one-fifth-acre plots needed for three common degrees of accuracy.

B-4.2.2. Strip Cruising. This method is essentially the same as the line-plot fixed radius method except, instead of circular plots, the sample area is a continuous strip along the cruise line. The width of the strip is the same throughout the cruise, either 33 feet or 66 feet in width. The cruise lines follow a predetermined compass course, and the cruise lines are spaced predetermined distances apart. A 5 percent cruise means the lines are 20 chains apart for a 66-foot-wide strip; a 0-percent cruise means the lines are 10 chains apart; and a 20-percent cruise means the lines are 5 chains apart. All trees are measured and tallied, and the same method of gathering data is used as in the line-plot system. This method is applicable to hilly and steeper ranges, whereas if the plot system were used, the area would be difficult to determine and subject to error. Also, this method is more advantageous where timber types break quickly, as it assures a good cross section of sampling (fig. B-5).

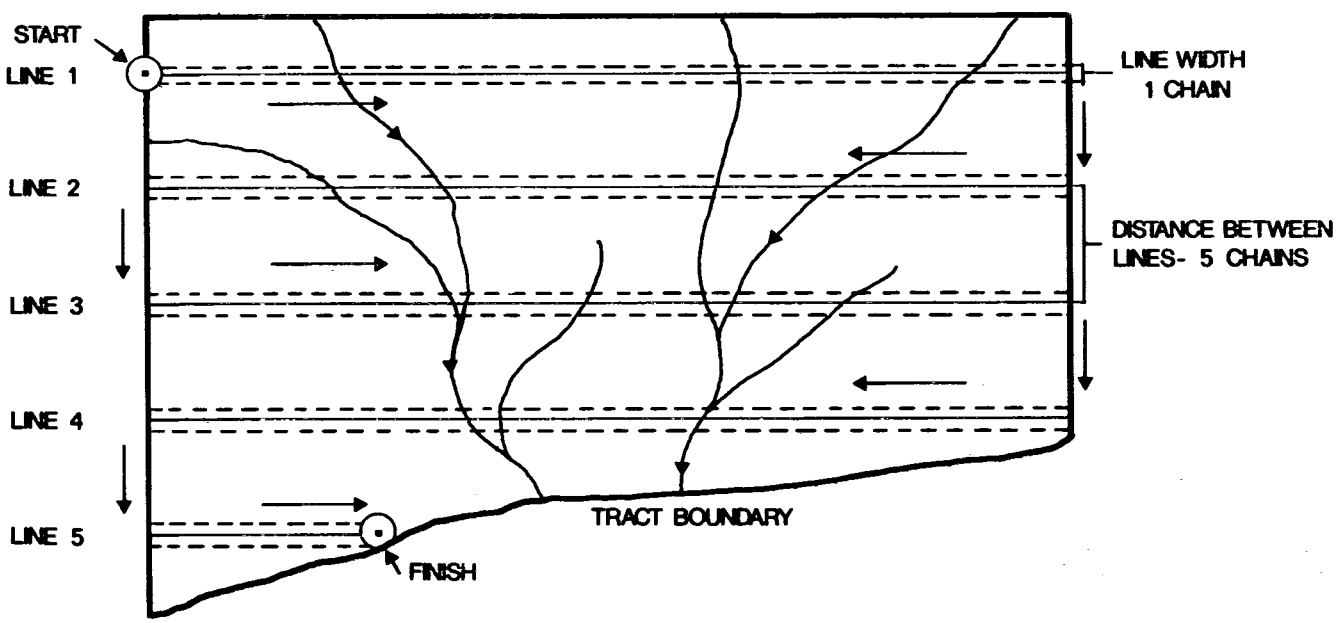


Figure B-5. 20 percent strip cruise.

B-4.2.3. Variable Plot or Point Sampling. Point sampling is a method of selecting trees to be tallied on the basis of their size rather than their frequency of occurrence. In plot sampling, the probability of tree selection is proportional to tree frequency; in point sampling, it is proportional to tree basal area. Variable plots do not require the measurement of the plot radius or tree diameters to compute the basal area. Stem counts are tallied without regard to diameter. A tree whose diameter is large enough to subtend a fixed angle of a prism or angle gauge of a specified basal area factor is tallied as "in" the plot (fig. B-6). Each tree carries equal weight in computing basal area per acre, regardless of its diameter. The Basal Area Factor (BAF) converts the stem count per acre to the basal area per acre. The count of each sample point, multiplied by the BAF, gives the total basal area in square feet of tree stems on a peracre basis. Precision-tested prisms that have an exact BAF simplify the computation. Prisms of BAF 10 are commonly used in the East for second-growth sawtimber or dense pole timber stands. BAF 5 is used in light-density pole stands, and BAF 20 for old-growth stands. In the western United States, prisms with a BAF 20 to 60 are in common usage. For acceptable results, a BAF should be selected for trees that will average a 5-to-12 tree count at each point. The number of sample points to be used depends on the average-size diameter of the timber being estimated; for example, for a 10-percent cruise of a 120-acre tract that has an estimated average tree diameter of 14 inches, the following formula gives the number of points necessary:

$$\frac{\text{Area of Tract} \times \text{\% Cruise}}{\text{Basal Area of Average Tree}} \times \text{BAF} = \text{Number of Points Necessary}$$

$$\frac{120 \times 10\%}{1.069} \times 10 = 112 \text{ Points}$$

An average diameter of 20 inches would require only 55 points. The smaller the average diameter, the more sample points will be necessary.

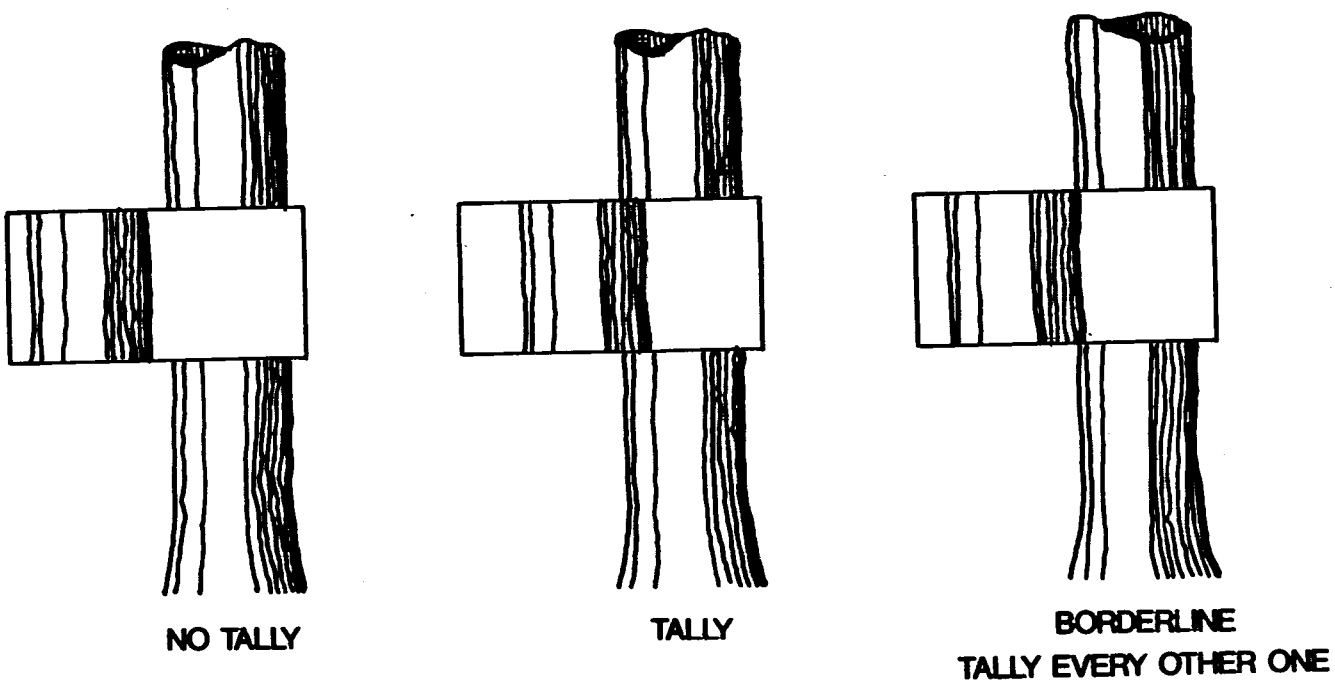


Figure B-6. Using prism to determine if tree is "in", "out", or borderline.

B-4.2.3.1. Field Procedure and Data-Gathering. Sampling methods which can be employed with fixed plots can also be used with point sampling. The points are analogous to plot centers; thus, the design can be random, stratified, or systematic sampling. At each point of sampling, by use of a prism or angle gauge instrument, the number of trees that fall in the imaged deflection are tallied (fig. B-7). If a simple overall volume per acre is desired, then only a tally of trees by product type is necessary. If additional information is required, then a complete field tally is in order in which every

sample tree is measured for height and DBH as well as surveyed to obtain the grade, form class, product class, and even crown class. Such a complete measurement system is ideal for computer processing. Porta-Punch cards are best adapted for this type of computer computation (figures **B-8, B-9** and **B-10.**

Figure B-7. Use of prism in variable plot cruising.

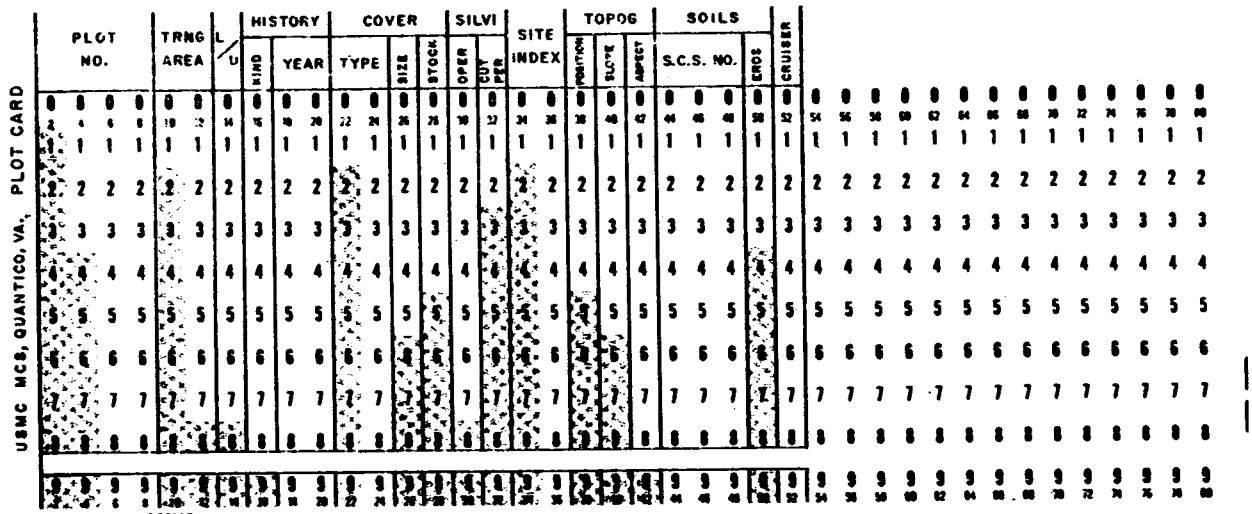


Figure B-8. Data processing punch card for individual plot for CFI.

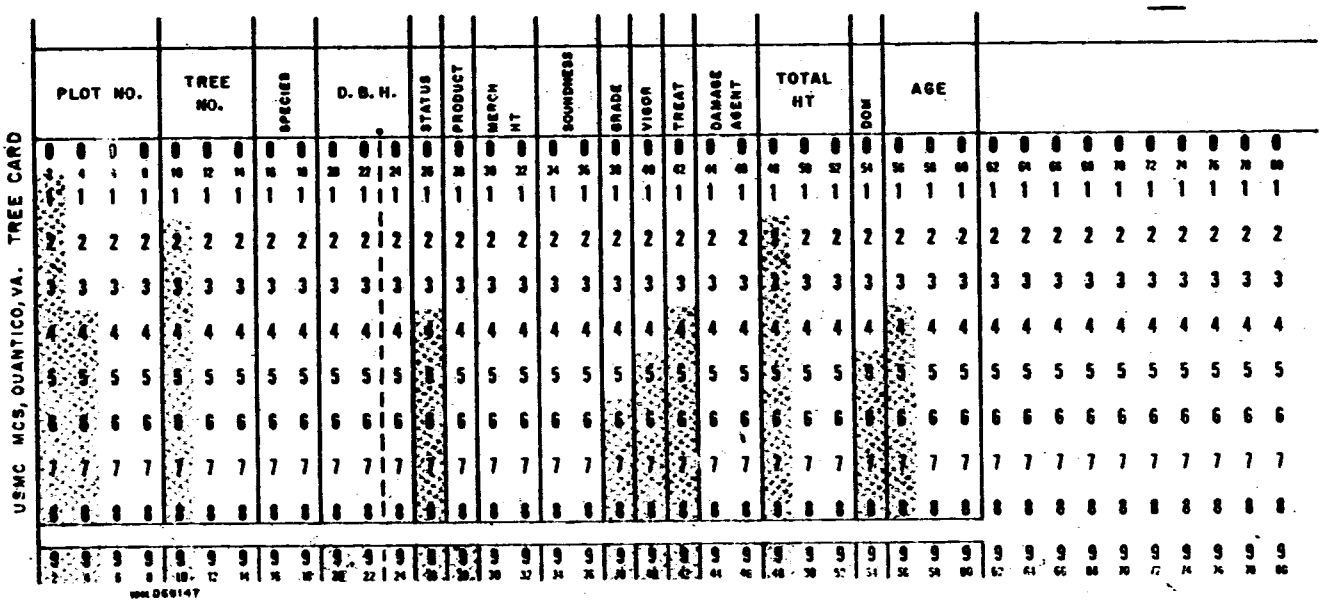


Figure B-9. Data processing punch card for individual tree for CFI.

COUNTY 115LOCATION 18

SAMPLE LOCATION SUMMARIES

SUM(1) = 417.6763 NUMBER OF LIVE TREES PER ACRE
SUM(2) = 86.1119 LIVE TREE STOCKING
SUM(3) = 343.5313 NET CU.FT. VOL. PER ACRE
SUM(4) = 196.2887 NET CU.FT. VOL. IN SAWLOG PORTION
SUM(5) = 37.6270 ANNUAL INCREASE IN NET BD.FT. VOL.
SUM(6) = 12.3418 ANNUAL INCREASE IN NET CU.FT. VOL.
SUM(7) = 598.7313 NET BD.FT. VOL. PER ACRE
SUM(8) = 26.0009 SQUARE FEET OF BASAL AREA

PROPORTION OF STOCKING BY SPECIES

6	.1510
22	.0348
29	.0488
39	.1231
46	.2323
49	.0627
50	.0453
64	.3021

RECORDED TYPE IS 53 COMPUTED TYPE IS 53

PROPORTION OF STOCKING BY TREE SIZE CLASS

STAND(1) = .8927 SEEDLINGS AND SAPLINGS
STAND(2) = .0000 POLE TIMBER
STAND(3) = .1073 SAWTIMBER

STOCKING BY TREE AND COVER CLASS

COND(1) = 26.6000 DESIRABLE TREES
COND(2) = 51.7119 ACCEPTABLE TREES
COND(3) = 3.9000 ROUGH TREES
COND(4) = 3.9000 ROTTEN TREES
COND(5) = .0000 INHIBITING VEGETATION
COND(6) = 10.0000 NONSTOCKED
COND(7) = .0000 NONSTOCKED AND OVERTOPPED
COND(8) = .0000 NONSTOCKABLE

AREA CONDITION = 61STAND SIZE = 40

NUMBER OF OVERSTOCKED POINTS = 2

19 = NUMBER OF RECORDS FOR SAMPLE LOCATION
COUNTY 115LOCATION 18

ST 4	SU 5	CO 6	PLOT 7	PT 24	TR 25	HIST 26	SP 27	TC 59	DBH 28	DBHI 29	BL 30	CFC 31	SL 32	TDOB 33	BFC 34	NOTR 60	STOCK 61	CF 62	CFSL 63	BFI 64	CFI 65	BF 66	BA 67	PO 100
28	2	115	18	1	0	0	0	6	.0	.00	0.	0.	0.	.0	0.	.0	10.0	.0	.0	.0	.0	.0	.0	0
28	2	115	18	2	1	1	611	3	13.3	.19	50.	0.	27.	9.0	0.	3.9	3.9	78.0	60.1	.0	2.6	.0	3.7	1
28	2	115	18	2	2	1	491	2	2.6	.00	5.	0.	0.	.0	0.	100.0	1.4	19.2	.0	.0	.0	.0	3.7	2
28	2	115	18	2	3	1	491	2	1.9	.00	6.	0.	0.	.0	0.	100.0	.8	10.4	.0	.0	.0	.0	2.0	3
28	2	115	18	3	1	1	521	2	2.8	.00	10.	0.	0.	.0	0.	100.0	5.4	26.9	.0	.0	.0	.0	4.3	1
28	2	115	18	3	2	1	611	2	1.4	.00	6.	0.	0.	.0	0.	100.0	5.4	5.7	.0	.0	.0	.0	1.1	2
28	2	115	18	4	1	1	131	1	3.0	.00	0.	0.	0.	.0	0.	.0	6.5	.0	.0	.0	.0	.0	.0	2
28	2	115	18	4	2	1	131	1	3.2	.00	0.	0.	0.	.0	0.	.0	6.5	.0	.0	.0	.0	.0	.0	1
28	2	115	18	4	3	1	68	1	2.2	.00	0.	0.	0.	.0	0.	.0	3.0	.0	.0	.0	.0	.0	.0	3
28	2	115	18	5	1	1	931	2	3.1	.00	0.	0.	0.	.0	0.	.0	6.5	.0	.0	.0	.0	.0	.0	1
28	2	115	18	5	2	1	931	2	3.1	.00	0.	0.	0.	.0	0.	.0	6.5	.0	.0	.0	.0	.0	.0	2
28	2	115	18	6	1	1	611	2	11.8	.19	48.	1.	20.	9.0	10.	4.9	4.2	70.9	46.5	10.8	2.9	209.6	3.7	1
28	2	115	18	7	1	1	837	2	11.7	.26	42.	0.	20.	11.1	0.	5.0	4.2	92.5	62.8	26.8	5.0	389.1	3.7	1
28	2	115	18	8	1	1	802	1	2.0	.00	0.	0.	0.	.0	0.	.0	5.4	.0	.0	.0	.0	.0	.0	1
28	2	115	18	8	2	1	491	2	1.9	.00	0.	0.	0.	.0	0.	.0	5.4	.0	.0	.0	.0	.0	.0	2
28	2	115	18	8	3	1	802	1	1.5	.00	0.	0.	0.	.0	0.	.0	5.2	.0	.0	.0	.0	.0	.0	3
28	2	115	18	9	1	1	316	4	13.4	.26	42.	5.	18.	9.8	0.	3.8	3.9	39.8	26.9	.0	1.9	.0	3.7	1
28	2	115	18	10	1	1	611	2	3.6	.00	0.	0.	0.	.0	0.	.0	6.5	.0	.0	.0	.0	.0	.0	1
28	2	115	18	10	2	1	621	2	1.4	.00	0.	0.	0.	.0	0.	.0	5.4	.0	.0	.0	.0	.0	.0	2
																417.7	96.1	343.5	196.3	37.6	12.3	598.7	26.0	

Figure B-10. Sample data processing print-out showing pertinent information.

B-4.2.3.2. Volume Determination. The volume of sample areas is derived from a ratio between the tree and its basal area. This is done by multiplying the average basal area per acre by the average Volume Basal Area Ratio (V-BAR). The V-BAR can be obtained from V-BAR tables which show the gross volume per square foot of basal area at the point of measurement, by diameter and height classes, and sometimes by form class. These tables are available from many sources, including Prism Cruising in the Western United States and Volume Tables for Use Therewith (App K, No. 52) and Log Scaling and Timber Cruising (App K, No. 53).

B-4.2.3.3. Applicability. This method is much quicker and lower in cost than other previously mentioned methods. The number of measured trees in each plot is considerably smaller. It is very adaptable to dense stands of small trees, especially when only the merchantable volume is desired. It has its drawbacks in areas of heavy underbrush and steep terrain. Its use in preparing an overall management plan can give an erroneous picture of the true stocking of small-size trees, which are in turn the basis for future ingrowth. The small sizes receive a much smaller percentage of sampling than the large sizes.

B-4.2.4. Three-P (Probability Proportional to Prediction) Sampling. This is a unique method of sample tree selection and volume determination, using precision measuring equipment, and lends itself to computer processing. The volume obtained by the Three-P system utilizes an extremely small sample of trees.

B-4.2.4.1. Sample Plots. Sample plots are selected randomlyntensity of the sample is based on the Coefficient of Variation (CV) which is a ratio of the standard deviation to the mean of the population. CV can be estimated from old inventories. In a CV of 20 percent with a desired sampling error of two percent, only 100 Three-P sample trees would have to be measured.

B-4.2.4.2. Selection of Sample Trees. Sample trees for actual measurement are selected by the prediction of volume and height for that tree with a computer-generated list of random numbers. The random numbers may be selected in the field by taking a random integer list to each plot as it is established.

B-4.2.4.3. Dendrometry Procedure. The Bar and Stroud Dendrometer is the most efficient instrument to use in measuring stem diameters and lengths of selected trees. The dendrometer is used to measure the diameter at breast height and at intervals up the stem to a minimum, predetermined top diameter. All diameters are taken outside the bark; the inside bark diameter (dib), for accurate volume computation, is computed through the use of dib-relationships and bark-thickness ratios. The volume and grade of each section can be computed for any type of unit measure.

B-4.2.4.4. Applicability. The use of the Three-P system has proven its accuracy, particularly on timber to be sold on a tree basis. It requires the availability of personnel trained in dendrometer measuring as well as the availability of computer programs. Although only a small number of trees need be measured, the technique does not reduce the number of trees to be visited in the overall inventory. The method is structured for volume determination rather than for all the other variables needed in proper resource management.

B-5. Continuous Forest Inventory (CFI).

B-5.1. Purpose and Characteristics. CFI is a system of permanently established sample plots that are periodically remeasured to update data necessary for the management of forest resources. The plots are systematically located so that the data obtained are a true representation of the changes that occur in the surrounding forest. These data provide the up-to-date basis for forest resource management decisions.

B-5.2. Plot Location. To determine the number of plots to be established, a statistical determination of sampling intensity is recommended. However, a rule of thumb which indicates the approximate number of plots that can be established can be used. The number is equal to 100+ .0025 × number of acres. From this formula, it can be seen that a minimum of 100 plots is needed for any size tract. For plot location, some form of stratified sampling, based on forest types and even topography, should be used. One-fifth-acre plots are the most efficient. A variable plot method can also be used.

B-5.3. Field Procedure. In this procedure, the necessary plots are first located, according to the sampling design, on the forest map and on the ground. The plot center is permanently marked by a driven metal stake, referenced by a metes and bounds survey from an easily-located starting point. All trees in the circular plot, 5 inches in diameter or larger, are numbered by either paint or metal tags. All trees are measured for diameter, pulpwood and sawlog heights, crown class, vigor, grade, operability, as well as growth data. The physical characteristics of the plot itself are also recorded, including the topography, site, density, forest cover, and stand condition. For proper recording and calculations, automatic data processing is required. All field data should be recorded on mark-sensed or punch cards in lieu of the usual field tally sheets. A tree card is needed for each tree, and one card is needed for each individual plot.

B-5.4. Remeasurement Interval. A remeasurement interval of 5 years, but no longer than ten, is recommended.

B-5.5. Applicability. Installations with 20,000 acres or more of commercial forest land, can justify the establishment of a CFI. To re-inventory the entire tract would be too costly as compared to the remeasurement of CFI plots. For installations with less than 20,000 acres of commercial forest land, the cost of remeasurement would justify a re-inventory on the same basis and using exactly the same methods as used in the original timber cruise without the need of a CFI system.

B-6. Allowable Annual Harvest.

B-6.1. General. In theory, the annual timber harvest is based upon the annual timber growth of the installation, the mortality loss from all sources, and the silvicultural needs of individual stands. All this information is derived from the overall timber inventory. However, changes occur due to military training requirements that alter the amount of timber available for cutting.

B-6.2. Application. Factors that affect the allowable annual cut include changing needs of the military mission of the installation, environmental considerations, conditions described in paragraph 1-2, and management of such special areas as those described in subparagraph B-3.5. The first priority in determining the amount of timber for harvest in the first phase of the cutting cycle is removal of mature or deteriorated trees and improvement of existing stands, but it must be recognized, of course, that only in extreme cases should the amount harvested exceed the net annual growth. Normally, the goal for all subsequent cutting cycles should be to maintain the annual harvest at a rate which is lower than the total net growth of the installation. This increases the productivity of the timberlands except in those instances where timber stands are already fully stocked.

B-6.3. Determination of Cut and Scheduling Program Cuts. To determine the actual allowable harvest, after taking into consideration other land uses, a cutting cycle should be established. Normally, this would be 10-year periods. Cutting plans covering longer periods may have to be revised due to changes in markets, utilization, road systems, logging methods and environmental reasons. During this time, the prescribed treatment of stands in all compartments should have been accomplished and the timber harvested as specified in the overall management plan. Prior to the sale of any timber, the volumes to be harvested from a cutting area should be accurately determined by the measurement of trees to be removed, or by a cruise of appropriate intensity if the area is to be clear-cut or cut back to seed trees. The original inventory can provide data to be extracted that will give the volume for each individual timber type. This figure will help in determining the amount of timber that a cutting area can and should provide.

B-6.4. Inventory Records. The installation's forest management plan should incorporate in table form the volume data produced by the overall installation inventory. Tables should summarize the total volume and predicted growth according to species and product for the entire installation. The management plan should also include a detailed breakdown for each compartment (Air Force and Navy use stand or block) showing not only total volumes but also volumes according to timber types, species, products, diameter and age classes, and growing sites. The acreage of each timber type should also be recorded. Current and up-to-date inventory data should be kept on compartment record sheets (fig. B-11). This should include the original volume, show changes in inventory due to harvesting and loss from other causes, and show volume gains due to growth. Silvicultural activities, with the acreages involved, should also be recorded on the record sheets. An installation base map should be maintained at a scale of 4 inches to the mile. The boundaries and identification of each compartment and stand or block (Air Force and Navy) should be shown on this map. Information concerning planned harvesting, areas already treated, and dates of actual timber harvests should be given for the appropriate compartment and stand or block (Air Force and Navy). This base map should be a visual record of timber harvests and silvicultural activities. Individual compartment maps, at a scale of 8 inches to the mile, should also be prepared. They will be essentially timber type maps as described in subparagraph B-3.1. All forest projects, including timber harvests, should be shown in the appropriate areas. Sale boundaries, past and present, should be delineated with treatment description, project number, and date of the activity.

SUGGESTED FORMAT

CURRENT TIMBER INVENTORY

INSTALLATION _____ COMPARTMENT NUMBER _____ 5-YEAR ROTATION

SPECIES AND PRODUCT	YEAR	VOLUME (b-o-y)[a]	PREDICTED ANNUAL GROWTH (Bd.Ft.)	TIMBER REMOVALS	MORTALITY FROM ALL CAUSES	VOLUME (e-o-y)[b]
Pine sawtimber	1975					
	1976					
	1977					
	1978					
	1979					
Hardwood sawtimber	1975					
	1976					
	1977					
	1978					
	1979					
Pine pulpwood	1975					
	1976					
	1977					
	1978					
	1979					

[a] b-o-y = beginning of year
[b] e-o-y = end of year

Figure B-11. Example of current timber inventory form.

B-7. Guide Specifications for Inventory Methods. Guidelines for using various inventory methods are outlined in table B-3.

Table B-1. Timber Type Classification Symbols

Species	Standard Size Class	Stand Density
Letter symbols: First letter of predominant species name, followed by first letter of secondary species name (at least 20 percent of stand)	Numerical symbols: 1 = seedlings and saplings, 0" -5" DBH[a] 2 = pole timber, 5" - 11" DBH 3 = small saw timber, 11" - 21" DBH 4 = large saw timber, 21" DBH and larger	Bar Symbols: - poorly stocked, 10 - 39% = medium stocked, 40 - 69% ≡ well stocked, 70 - 100%

Stand Condition	Non-Forest Cover	Site Index
Letter symbols: X = recent clearcut, nonstocked X-O = old clearcut, nonstocked F = area deforested by fire Y = area deforested by other cause PL = plantation C = coppice R = residual stand after partial cutting	Letter symbols: A = agriculture G = grass or brush O = nonvegetative NCF = noncommercial forest	Numerical symbols: Symbol is generally shown in most forest areas by height of tree at a given age.

Examples:		
	LP4≡vp(80)	Loblolly pine, large sawtimber, well stocked and mixed with Virginia pine (over 20% of volume), on a site class of 80.
	PLD1≡1938	Planted stand of Douglas fir seedlings, planted in 1938.

[a] DBH is the standard abbreviation for Diameter at Breast Height which is taken at four and one-half feet above ground level.

Table B-2.
Number of Plots Needed for Three Common Degrees of Accuracy [a]
One-Fifth-Acre Plots, Uniformly Spaced

Condition of Stand	Uniform			Average			Patchy	
Stocking[b]	Good	Medium	Poor	Good	Medium	Poor	Medium	Poor
Area in acres	Plus or minus 5% accuracy							
40	57	109	160	89	133	171	160	185
160	73	185	400	133	267	480	400	600
640	78	223	640	152	356	873	640	1,371
5,000	80	238	775	159	394	1,145	775	2,190
10,000	80	239	787	159	397	1,172	787	2,290
100,000	80	240	799	160	400	1,197	799	2,389
Area in acres	Plus or minus 10% accuracy							
40	18	46	100	33	67	120	100	150
160	20	56	160	38	89	218	160	345
640	20	59	188	40	97	274	188	505
5,000	20	60	198	40	100	291	198	586
10,000	20	60	199	40	100	298	199	593
100,000	20	60	200	40	100	300	200	599
Area in acres	Plus or minus 20% accuracy							
40	5	14	40	10	22	55	40	86
160	5	15	47	10	24	69	47	126
640	5	15	49	10	25	73	49	143
5,000	5	15	50	10	25	75	50	149
10,000	5	15	50	10	15	75	50	150
100,000	5	15	50	10	15	75	50	150

Note: Two-thirds of cruises made will probably come within the indicated percentages of complete accuracy. One-third may exceed these percentages.

[a] "Three-Pee Sampling Theory and Program in 'THRP' for Computer Generation of Selection Criteria", L. R. Grosenbaugh, U.S. Department of Agriculture, Forest Service, June 1975.

[b] Good Stocking is 2/3-to-full stocking. Medium stocking is 1/3-to-2/3 full stocking. Poor stocking is less than 1/3 full stocking.

Table B-3.
Guide Specifications for Inventory Methods

Purpose of Inventory	Usable Inventory Methods
1. Initial inventory for overall management plan	Fixed radius plot Point sampling (Design: Systematic)
2. Timber inventory for sale purposes	
2.1. Clear cut or seed tree sales	Strip method Fixed radius plot Point sampling (Design: Systematic or stratified)
2.2. Selective harvest	
2.2.1. High timber values	100% tree measurement
2.2.2. Low timber values	100% tree marked with sample tree measurement
2.2.3. Heavily dense small timber	100% tree marked with sample tree measurement
3. Continuous Forest Inventory	
3.1. Plot establishment	Fixed radius plot Point sampling (Design: Systematic or stratified)
3.2. Plot remeasurement	Three-P or 100% measurement
4. Appraisals	
4.1. Damage on small areas	100% tree tally
2. Damage on large areas	Fixed radius plot Point sampling (Design: Systematic)
3. Land Sales or exchange	Fixed radius plot Point sampling (Design: Systematic)

APPENDIX C*

SAMPLE DECLARATION OF TIMBER AVAILABILITY

Subject: Timber Available for Disposal at ..... *(installation)*

To: *(Appropriate Authority prescribed by regulations)*

1. The following estimated volume of timber has been marked for disposal at ..... *(instlallation)* in accordance with ..... *(appropriate regulation or instruction)* and the approved Forest Management Plan for ..... *(installation)*

1.1. *Sawtimber* (basis, Scribner Decimal C log rule to 8-inch top).

2,100,000 board feet of mixed southern pine (or named species), 10–36 inches DBH, average 14 inches DBH, totaling 17.569 trees, with 25 percent probably most valuable as poles or piling.

18,000 board feet of mixed hardwoods (or named species), 12–50 inches DBH, averaging 16 inches DBH, totaling 134 trees. These trees are scattered in 10 of the cutting units.

1.2. *Pulpwood* (basis standard cords).

1,500 cords of mixed conifer stems, 5–9 inches DBH, plus a few larger trees not suitable for other products.

400 cords of pine topwood to be cut after loggers have finished.

2. This timber is located in 30 cutting units of Compartment IV within an operable area of approximately 3,004 acres. (See Inclosure No. 1 for volume and number of trees marked by cutting units.) Title to land and timber is fee simple. See locality map, Inclosure No. 2, for general location of the area and its relation to roads, railroads, and shipping points.

3. Circumstances prompting removal are—

3.1. Sawtimber is mature to decadent and will be wasted by decay and death if allowed to remain longer in the stand.

3.2. Younger stands must be thinned due to overcrowded conditions.

4. The estimate is (is not) considered sufficiently accurate to permit disposal by lump-sum sale without monetary loss to the Government.

5. The following specifications should be included in any contract awarded, or modified only after complete concurrence by the installation commander.

5.1. Cut all trees marked with ..... *(color)* paint at ground level and breast height.

5.2. Cut stumps as low as possible, and in no case more than 10 inches above ground on the highest side, except when ingrown stones or metal, or excessive rootswell make the low height impracticable.

5.3. Limb all several pine tops to a maximum of 4 feet above ground and leave no tops or slash within 3 feet of any residual living tree.

5.4. Remove all logs and bolts within 24 hours after they have been cut, unless authorized by the resident inspector to allow them to remain.

5.5. Marked trees overlooked by cutters must be cut as soon as contractor is notified. The cutting of any unmarked tree will be penalized on the basis of $ ..... per inch in diameter measured at the stump.

5.6. Cutting must proceed in an orderly manner and only in the location designated by the resident inspector.

5.7. Sawmills will (will not) be permitted on the installation (subject to the following restrictions).

5.8. The location of all logging roads, landings, and skid roads must be approved by ..... All firelanes, streams, and trails must be kept free of tops, slash, structures, and unused equipment.

5.9. The contractor will be held liable for all damage to Government property and for all Government expenditures resulting from fires caused by his negligence or the negligence of his employees, agents, and subcontractors.

5.10. The contractor will comply with all pertinent provisions of the General Safety Regulations, ... *(cite reference applicable to Department involved)*

6. Cutting must be completed no later than .....

*Applicable to Army installations only.

APPENDIX D

REFERENCES

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2. Herbicide Manual For Noncropland Weeds—TM 5-629/AFM 91-19/NAVFAC MO-314, August 1970.
3. Natural Resources—Land Management—TM 5-630/AFM 126-2/NAVFAC MO-100.1.
4. AR 200-1, Environmental Protection and Enhancement.
   AR 420-74, Natural Resources—Land, Forest, and Wildlife Management.
   AFR 19-2, Environmental Impact Analysis Process.
   AFR 91-21, Pest Management Program
   OPNAV INST 6240.3E, Environmental Protection Manual.
   MCO P11000.8, Real Property Facilities Manual, Vol. V Environmental Management.

APPENDIX E

RECOMMENDATIONS FOR PERSONNEL AND EQUIPMENT REQUIREMENTS AT MILITARY INSTALLATIONS ACCOMPLISHING FOREST MANAGEMENT

Line No.	Type	Units required for stated forest acreage						
		1,000 or less	5,000	10,000	20,000	50,000	125M	250M
1.	Personnel[1]—Professional[2]	1/4	1	1	1	2	3	4
2.	Personnel[1]—Other	1/4	1	1	2	4	12	24
3.	Ax, DB or SB, 31/2-5 lb.	1	2	4	8	12	20	30
4.	Backfire torch	2	2	3	4	6	8	12
5.	Backpack pump, 4 gal.	4	6	10	12	24	30	3 6
6.	Biltmore stick	2	2	3	4	5	9	12
7.	Boots, safety steel toe, lightweight moccasin toe, lace type w/lug soles.	1 Pr. ea. Permanent Employee						
8.	Brush hook or bank blade	2	2	3	4	6	12	24
9.	Camera	-	-	1	1	1	1	1
10.	Compass, forester	-	1	2	2	2	3	4
11.	Compass, staff	-	1	1	1	1	2	2
12.	Drum chopper	-	-	-	-	-	1	1
13.	Fire danger weather station[3]	-	-	1	1	1	2	3
14.	Fire finder, lookout, osborne or plain alidade	-	1	1	1	1	2	3
15.	Fireplow, heavy, 2 or 4 disc	-	-	-	1	1	2	4
16.	Fireplow, light, 2 disc	-	1	1	1	2	4	8
17.	Fire rake	4	8	16	32	48	80	120
18.	Fuel container *safety*, 5-gal, 2-gal, 1-gal	3	3	3	3	6	12	18
19.	Fusee, forester or railroad	24	36	48	48	60	120	120
20.	Grader, road	-	-	-	1	2	2	4
21.	Hatchet, hypo, herbicide	1	1	2	3	4	6	8
22.	Hats, hard	1 ea. Permanent Employee						
23.	Increment borer, 12 inch; increment hammer	1	1	1	1	2	3	4
24.	Injector, tree herbicide	1	1	2	3	4	6	8
25.	Land clearing machine	-	-	-	-	1	1	1
26.	Level, hand, abney or clinometer	1	1	1	2	2	3	4
27.	Lights, battery, hand held or head type	6	12	25	30	36	48	48
28.	1Lookout tower 1	-	1			1	2	3
29.	Paint gun, tree marking 1-qt. manual or 1-gal pressure	1	1	2	3	6	8	12
30.	Planimeter, compensating polar	-	1	1	1	1	2	2
31.	Planter, tree, tractor drawn	-	-	1	1	2	2	3
32.	Prism, cruising or angle gauge	1	1	1	2	4	5	8
33.	Pulaski tool	2	4	6	8	12	24	36
34.	Pump[4], water, fire, slip-on, w/200-250 gal. tank	-	1	1	1	2	4	6
35.	Radios, 2-way, vehicle	-	2	3	3	5	8	10
36.	Radios, 2-way portable unit	1	1	2	4	6	10	20
37.	Radios, base station and remote	-	-	2	2	2	3	4
38.	Rake, fire	8	12	24	36	48	84	110
39.	Saw, bow 36"	1	1	2	2	4	6	10
40.	Saw, chain, gasoline powered	-	1	3	3	4	6	8
41.	Saw, pole pruning	-	-	1	2	4	6	8
42.	Seeder, handoperated, cyclone type	1	1	2	2	4	6	8
43.	Shovel, LH, RP	8	12	16	20	24	30	40
44.	Snakebite Kits	1	2	3	4	8	12	24
45.	Stereoscope, pocket	-	1	1	1	2	2	3
46.	Swatter, grass fire	10	15	35	50	80	100	130
47.	Tally book 8 by 11 inches, metal	1	1	1	2	2	4	6
48.	Tally meter, single or multiple dial	1	1	1	2	3	4	6
49.	Tape, steel, surveyors, 100' 200', 2-chain topo	1	1	1	2	2	4	6
50.	Tape, steel, fixed radius plot measuring (1/10 ac, 1/5 ac, 1/4 ac, etc)	1	1	1	2	2	4	6

Line No.	Type	Units required for stated forest acreage						
		1,000 or less	5,000	10,000	20,000	50,000	125M	250M
51.	Tape, three diameter, direct reading, LH, RH	1	1	2	3	6	12	20
52.	Tractor[5], crawl 34-45 DBHP	-	1	1	2	3	5	8
53.	Tractor [5], crawl, D-6, D-7 or D-8	-	-	-	1	1	2	4
54.	Tractor, w/transport trailer	-	-	-	1	1	2	3
55.	Truck, pickup 4x4, 1/2T or 3/4T	-	1	1	2	2	3	5
56.	Truck, light tractor transport 21,000-23,000 GVW w/hydraulic tilt bed and loading winch	-	1	1	1	2	4	8
57.	Truck, 1-T, 4x4, w/250 gal slipon tank	-	1	1	1	2	4	8

(1) Man-years, permanent.
(2) Professional forester.
(3) When other stations cannot provide the data.
(4) If justified by local conditions.
(5) Including winches, dozer blades, headache racks, hydraulic pump units as necessary.

Note: The items listed are provided as a guide in determining local requirements.

APPENDIX F

DIMENSIONS AND AREA OF SQUARE AND ROUND PLOTS

Area		Linear feet	
Acres	Square feet	Square plot, 1 side	Circular plot, radius
1.0	43,560	208.7103	117.7522
3/4	32,670	180.8000	101.8000
1/2	21,780	147.5805	83.2634
1/3	14,520	120.4990	67.9843
1/4	10,890	104.3552	58.8761
1/5	8,712	93.3381	52.6604
1/6	7,260	85.2056	48.0721
1/7	6,223	78.8851	44.5061
1/8	5,445	73.7902	41.6317
1/9	4,840	69.5701	39.2507
1/10	4,356	66.0000	37.2365
1/50	871	29.5161	16.6527
1/100	436	20.8710	11.7752
1/1000	43.6	6.6000	3.7237
10.0	435.600	660.0000	372.3651
100.0	4,356,000	2,087.1033	1,177.5219

APPENDIX G

MEASUREMENT EQUIVALENTS

LINEAL MEASUREMENT EQUIVALENTS

Units	Mile	Feet	Inches	Chains	Meters	Kilometers
1.0 mile	.....	5,280	63,360	80	1,609.3	1.6093
1.0 chain	0.0125	66	792	.....	20.12	.0201
1.0 meter	.0006	3.281	39.37	.0497	.....	.001
1.0 kilometer	.6214	3,280.800	39,369.6	49.7	1,000.0	.....
1.0 foot	.0002	.....	12	.015	.3048	.0003
1.0 rod, perch or pole	.0031	16½	198	.25	5.0292	.0050

AREA MEASUREMENT EQUIVALENTS

Units	Square mile	Square feet	Square chains	Acres
1.0 square mile	.....	27,878,400	6,400	640
1.0 square foot	.....	.....	.00023	0.00002
1.0 square chain	0.000156	4,356	.....	.1
1.0 acre	00156	43,560	10.	.....
1.0 hectare	.0037	107,638.7	24.710	2.471

CONVERSION FACTORS, U. S. CUSTOMARY TO METRIC (SI) AND METRIC (SI) TO U. S. CUSTOMARY UNITS OF MEASUREMENT

Multiply	By	To Obtain
	U. S. Customary to Metric (SI)	
inches	2.54	centimeters
feet	0.3048	metres
yards	0.9144	metres
miles (U. S. statute)	1.609344	kilometres
square inches	6.4516	square centimetres
square feet	0.09290304	square metres
square yards	0.8361274	square metres
acres	0.004047	square kilometres
acres	0.4047	hectares
cubic yards	0.7645549	cubic metres
cubic feet per second	0.02831685	cubic metres per second
pounds (mass)	0.4535924	kilograms
tons (short)	907.1847	kilograms
inches per hour	0.04234	centimetres per minute
feet per second	0.3048	metres per second
degrees (angular)	0.01745329	radians
	Metric (SI) to U. S. Customary	
centimetres	0.3937007	inches
metres	3.280839	feet
kilometres	0.6213711	miles (U. S. statute)
square centimetres	0.1550	square inches
square metres	0.00025	acres
square kilometres	247.105	acres
hectares	2.471	acres
kilograms	2.204622	pounds (mass)

APPENDIX H

STANDARD CONVERTING FACTORS FOR STATISTICAL USE

Number of units	Product	Assumed unit dimensions	Equivalent
			Board feet
2	Cord, standard	4 × 4 × 8 feet	1,000
1	Cord, long	4 × 5 × 8 feet	625
1	Cord, shinglebolts	4 × 4 × 8 feet	600
3	Cord, small (under 5-inch averaged)	4 × 4 × 8 feet	1,000
1	Cord, short	4 × 3 × 8 feet	375
1	Cord, short (under 5-inch averaged)	4 × 3 × 8 feet	250
10	Cubic feet	13.6 inches × 1 foot	60
6	Lagging	3 inches × 6 feet	10
1	Pole, converter or fence	4 inches × 20 feet	10
5	Pole, (phone) or piling	8 inches × 45 feet	1,000
10	Pole, (phone) or piling	8 inches × 35 feet	1,000
1	Pole, (phone) piling	7 inches × 60 feet	280
5	Pole, (phone) or piling	7 inches × 50 feet	1,000
10	Pole, (phone) or piling	7 inches × 40 feet	1,000
20	Pole, (phone) or piling	7 inches × 25 feet	1,000
1	Pole, (phone) or piling	5 inches × 25 feet	30
10	Post, fence	5 inches × 7 feet	50
175	Post, fence, mixed size	(Mixed) × 7 feet	1,000
70	Post, fence, mixed size	Mixed dimensions	[1] 1
10	Post, split	18 inches circumference × 7 feet	60
1	Prop	6 inches × 10 feet	10
1	Tie, 8 feet standard	7 × 9 inches	42
1	Tie, 8 feet standard	7 × 8 inches	37
1	Tie, 8 feet standard	6 × 6 inches	24
1	Tie, 6½ feet narrow gage	7 × 8 inches	30
1	Tie, 6½ feet narrow gage	6 × 6 inches	20

[1] Cord.

Note. Local conversion tables should be developed if above data are not considered appropriate for local conditions.

APPENDIX I

APPROXIMATE WEIGHTS OF COMMERCIALLY IMPORTANT WOODS

Species	Pounds per cubic foot		Pounds[1]	
	Green	Airdry[1]	Per cord 4'×4'×8'	Per M board feet lumber[2]
Ash, commercial white	48	41	3,700	3,420
Aspen	43	26	2,300	2,260
Bald cypress	51	32	3,200	2,670
Birch (average sweet, yellow)	57	44	.....	3,750
Cedar, eastern red	37	33	3,000	2,790
Cedar, northern white	28	21	.....	1,830
Cedar, southern white	26	23	1,950	1,980
Cedar, western red	27	23	2,100	1,920
Cherry, black	45	35	3,250	3,010
Douglas-fir (Rocky Mountain)	35	30	2,900	2,540
Douglas-fir (coastal)	38	34	3,250	2,860
Fir, white (averaged 2 species)	46	27	.....	2,250
Hemlock, eastern	50	28	.....	2,420
Hemlock, western	41	29	.....	2,470
Oak, red (averaged)	64	44	.....	3,670
Oak, white (averaged)	63	47	.....	3,920
Pine, loblolly	53	36	.....	3,020
Pine, longleaf	55	41	.....	3,470
Pine, shortleaf	52	36	.....	2,970
Pine, ponderosa	45	28	.....	2,380
Pine, Norway	42	31	.....	2,620
Redwood (old-growth)	50	28	.....	2,330

[1] Airdry, 12 percent moisture assumed, plus or minus 10 percent allowed.
[2] Rough.

APPENDIX J

PAINT-MARKING INFORMATION

J-1. A good grade of tree-marking paint will leave a clear mark for at least 2 years.
J-2. The forester, marking in average pulpwood stands in the South, is estimated to mark: .1,000 trees daily and to use 5 quarts of paint.
J-3. Paint guns range from small hand types to pressure-operated backpack types.
J-3. The *hand-pressure gun* is lighter and less expensive to buy and to repair.
J-3.2. The *backpack pressure gun* eliminates much hand fatigue and time lost in reloading.
J-4. Give paint gun frequent cleaning to keep nozzle and plunger in good working order. Clean with kerosene before storing.
J-5. Plunger and nozzle wear out in use. Never continue to use worn parts.
J-6. Use a distinctive color of paint for each of the various purposes.
J-7. The usual boundary mark comprises three parallel lines near breast height, crossed by one vertical line which faces the actual boundary line.

APPENDIX K

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GLOSSARY

Afforestation—Establishment of a forest on an area not previously forested. (*See* Reforestation.)

Age, rotation—The age at which the timber stand is consider ready for harvesting under the approved plan of management.

Age, stand—The average age of the trees which compose a stand, or a "story" within a stand.

All-aged—A stand of trees theoretically including all ages from seedling to overmature

Angle gage—*See* Prism.

BAF (based area factor)—A factor computed for a wedge prism or angle gage that when multipled by the number of trees at a point gives basal area per acre.

BAF 75—A wedge prism or angle gage having a factor of 75.

Basal area—In forestry, the area, usually expressed in square feet, of the cross section at breast height inside bark (unless otherwise stated), of either a single tree or of all the trees in a stand.

Board foot—A unit of tree and lumber measure 1 foot long, 1 foot wide, and 1 inch thick, Abbr.—Ft. b.m., FB.M., bd.-ft. In practice the unit is 1,000 board feet measure. M b.m.

Borer, increment—An augerlike instrument with a hollow bit, used to extract cores from a tree, pole, or sawed timber, for growth rate and age determination, or preservative penetration.

Butt cut—The first log (butt log) above the stump.

Climax forest—The final stage of a succession of forest tree species which continues to occupy an area as long as climatic or soil conditions remain unchanged.

Coppice—A cutover area regenerated by sprouts.

Cruise—A survey of forest land to locate timber and estimate quantity by species, products, or other characteristics; the estimate obtained in such a survey.

DBH—Symbol for "diameter breast high," 4½ feet above average ground level.

Duff—Forest litter an dother organic debris (in various stages of decomposition) on top of mineral soil.

Even aged—A stand of trees in which relatively small age differences exist between individuals. Maximum difference normally permitted is 10 to 20 years, although when stand exceeds 100 years in age differences up to 25 percent of rotation age are permissible.

Forest management—As used herein, is the application of sound forestry principles and practices, including proper protection, to the operation of the woodlands of the installation within the limitations of military missions and regulations and the local growing conditions.

Forest, potentially productive—Natural stands of young trees of commercially valuable species not yet of commercial size; areas reforested or to be reforested; old burns, cutover land, gravel pits, and similar areas capable of growing valuable timber if reforested.

Forest, productive—Those stands of hardwood and coniferous timber containing trees of commercial size, suitable for use by the installation or in demand by industry; normally trees over 5 inches DBH.

Forester—A person who has been professionally educated in forestry, or who possesses qualifications to practice forestry which are essentially equivalent to graduation from a recognized forestry school.

Forestry—The scientific management of forests for the continuous production of goods and services.

Gross scale—Scale of a log in which there is no deduction for defect.

Growing stock—The sum, by number or volume, of all trees in a forest or a specified part thereof.

High-grading—Removing only the best trees from the woodland.

Hypsometer—An instrument used to measure heights of trees, based either on geometric or trigometric principles.

Ingrowth—The volume or number of trees which have grown past an adopted lower limit of measurement during a specified period. Syn.—*recruits.*

Intolerance—The inability of a tree to develop and grow in the shade of and in competition with other trees.

Landing—A place where logs are assembled for transportation in loads or rafts. Syns—*bank; banking ground; log dump; rollway; yard.*

Net scale—The scale of a log after decution for defect.

Overstory—That portion of the trees in a forest forming the upper crown.

Prism. (wedgeprism, BAF prism)—A glass prism or angle gage used to compute volumes in timber cruising. BAF is Basal Area Factor. (*See* BAF.)

Pulaski—A combination ax and hoe used for the fire control.

Pulpwood—Wood cut or prepared primarily for manufacture into woodpulp. May be from tree bole (stemwood) or large limbs (topwood).

Minimum diameter and length as specified by local practice (in the Southeast, usually 4 inches inside bark and 5 feet 3 inches in length).

Reforestation—The natural or artificial restocking of a previously forested area with forest trees. *(See Afforestation.)*

Regeneration—The natural processes by which a forest is renewed.

Sawlog—A log large enough to permit production of lumber or other products by sawing. Size and cull percent permitted must be specified in any contract; it varies with local practice or regulations.

Sawtimber—Trees, of commercial species, which contain at least one merchantable sawlog.

Scribner decimal C log rule—An official log rule of the U.S. Forest Service and of the Department of Defense. Basically, it is the Scribner log rule modified by rounding off the last digit to the nearest 10 and dropping the cypher.

Example: Scribner 213 bd. ft., Decimal C 21.0.

Shelterwood—A system of management requiring the removal of the mature timber in a series of cuttings which extends over a period of years to permit natural reproduction.

Site Quality index—An index of the crop-producing capability of forest land as determined by the average height of dominant and codominant trees of stated species at a given age (usually 50 years). Syn.—*site class index.*

Slash—Debris remaining after logging, pruning, thinning, or brush cutting; large accumulations of debris after wind or fire. Included are logs, chunks, bark, branches, stumps, brush, broken and uprooted trees.

Uneven-aged—Term applied to a stand in which there are considerable differences in age of trees and three or more age classes are represented.

Note: For other terms and definitions, see "Terminology of Forest Science, Technology Practice and Products" Society of American Foresters, 1971.

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